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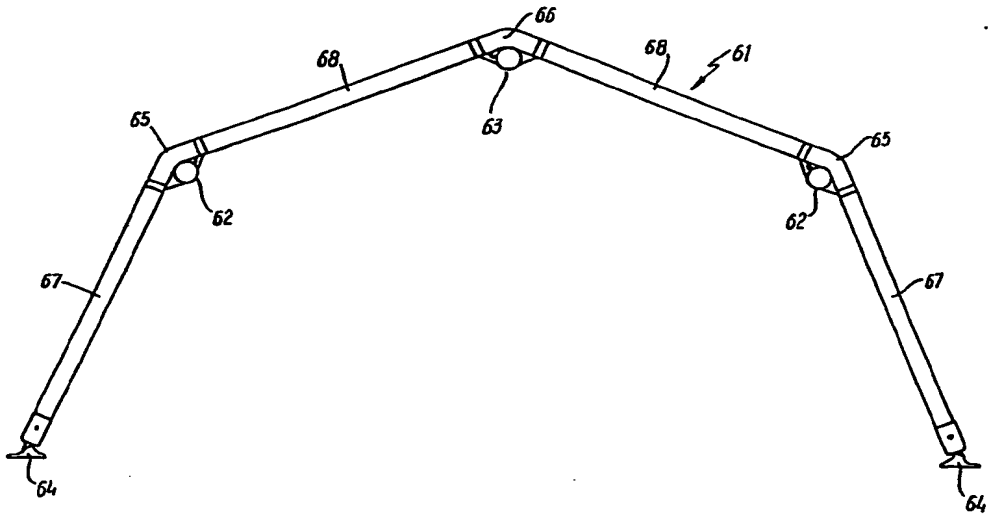

(57) Abstract

An inflatable building is made up of a framework which consists of a plurality of arches (61) interconnected by purlins such as eave purlins (62) and ridge purlins (63), the lower ends of the arch (61) being secured to ground or floor fitments (64). Each arch (61) can have two wall portions (67) and two roof portions (68) (although obviously a greater or lesser number of such portions can be provided). Junctions, such as eave junctions (65) and ridge junctions (66) can be made by manufacturing each tubular arch of individual tube lengths and joining them with connectors, but desirably each arch (61) is continuous and has an angle formed by shaping the material of the arch (61) during construction thereof, the arch (61) being secured to the purlin (62, 63) at the junction by tension means such as strapping, the whole framework composed of the arches (61) and the purlins (62, 63) and supporting a membrane on the inside or outside thereof.

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INFLATABLE BUILDING

This invention relates to an inflatable building which can be a tent, marquee or combarable structure. The building can be permanently or temporarily inflatable.

In PCT Applications Nos. PCT/GB 86/00757 and PCT/GB 88/01016 there are described inflatable tubes and methods for making them. Further comparable methods are described in my co-pending Applications Nos. and filed simultaneously herewith.

It is an object of the present invention to provide an improved inflatable building.

The invention provides an inflatable building including a plurality of arches each constituted by an inflatable tube structure and purlins interconnecting said arches.

Each arch can be a single inflatable tube with bends, or can be a plurality of individual straight tubes joined together.

The joints can be affected by end caps being provided with hinges which connect to the next tube.

Preferably, however, the arches are each made from a continuous tube, each tube having been made from an inner envelope of air impermeable expansible material disposed within an outer sheath of reinforcement material, the two having been urged into contact and adhesive used to secure the two together in accordance with the afore described method.

Each joint is preferably made by manufacturing a straight tube

of reinforcement material (which may be woven, knitted or otherwise formed). To form a joint, the tube is treated at a desired joint position so that walling of the tube on one side becomes shorter than the walling on the other side and, thereafter, the inflatable envelope is disposed within the tube and inflated to contact and become adhered to the outer tube of reinforcement. To form the bend in the outer cylindrical shell, walling on one side can be shrunk and/or walling on the other desired side can be expanded. However, expansion of the reinforcement shell on the outer side can cause weakening of the reinforcement and is therefore not preferred. It is desirable that the reinforcement of the inner side be shrunk so as to reduce in length. This can be effective in various ways depending upon the material chosen. Some fabric reinforcement shells can be shrunk by the applications of radiation or solvents. Some can be shrunk by the application of heat. Use of a heat shrinkable reinforcement shell is much preferred as it is a simple and easily consoled process. To aid forming a rigid or inflatable elbow shaped piece can be disposed within the straight reinforcement cylindrical shell before treatment of the joint occurs so that as the cylindrical shell is formed through the desired joint shape it takes up the size of the elbow. An inflatable elbow is desirable as it can then be deflated before removal for the use. The step of creating a joint can be effected prior to the additional end caps by any of the methods disclosed in my aforesaid applications or my aforesaid co-pending applications.

Purlins can be attached by having joints comparable to the

joints described in relation to the arch which has individual tubes. However, the invention further provides a building including a plurality of arches and a plurality of purlins, the arches being in the form of an inflated tube having one or more angles, at least one purlin bridging two or more arches and being connected to corresponding angles on the arches.

Desirably the purlins are connected by strapping to the tubes. Preferably the strapping is such as to resist un-bending of the angle under the inflation pressure within the tube.

The purlin diameter should be equalled to or greater than the tube diameter in order that the uniting forces between them tend either to bend or to collapse slightly the tube rather than the purlin. It is important that the tube does not exert any bending or crushing force on the purlin.

Preferred embodiments of the invention may incorporate one or more of the following features.

1. A number of interconnected inflatable tubes.
2. The inflatable tubes can be vertical or at an angle.
3. The inflatable tubes can be horizontal.
4. They can be of different of similar diameter.
5. They can be terminated at each end by a plastic, metal or fabric cap.
6. The cap can have incorporated a quick release connection.
7. The quick-release connection can be a plug in which case gas can travel freely in and out of the tube.
8. Alternatively the quick-release connection can be a socket in

which case gas is prevented from entering or exiting the tube by a non return valve which can only be de activated by the insertion of the plug section of the quick-release connection.

9. The other end of the quick-release connection (plug or socket) can be connected to a central node.

10. The central node can have a plurality of interconnected tubes which allows other connectors, instruments and valves to be screwed into or otherwise fixed to the node.

11. The central nodes providing a central connection between vertical and horizontal tubes can also be connected to a footwell or other means of pinning the inflated tent to a base or the ground.

12. An outer membrane composed of canvas, cloth, polyester or some other synthetic material can be affixed to the inflated tubes by means of touch-and-close fasteners such as those sold under the Trade Marks Velchro and Cric-Crac to form a light impervious skin.

13. Alternatively an extruded plastic or other more substantial and rigid material can be affixed in the same manner to form a more vandalproof or permanent enclosure.

14. Alternatively horiculturual polyethylene sheeting known commercially as 'POLYTHERM" AF or some similar product able to transmit the maximum amount of non harmful sunlight during the day whilst retaining the re-radiated heat normally lost at night could be used to clad the inflated building to act as a greenhouse.

15. Alternatively a combination of materials can be used to form vandalproof cladding and yet allow the maximum transmission of light during the day with retention of heat at night.

16. The cladding and roof covering can be affixed by a touch-and-close fastener on both sides of the inflatable tubes to form more efficient thermal insulation.

17. The cladding attachment to the inflatable tubes is tensioned by means of inflation making is almost impossible to remove until that tube or tubes is/are deflated when they are relatively easy to detach.

18. The various tubes can be constructed in accordance with the general method described in PCT Application No. PCT/GB88/01016 and British Patent Application No. 8903480.

19. Each tube can be removed from the tent or building without allowing gas to escape from the rest of the tubes by ensuring that the socket end of the quick-release mechanism with the non return valve is in the node rather than the tube.

20. If the socket end of the quick-release mechanism is affixed in each tube rather than the node all other tubes connected to that node must be detached but by this method it is possible to pressurise one or some of the tubes of the tent or building to a higher pressure than that required by the tent or building when it is deployed at a base camp in order to transport it/them with the rest of the tent or building in site in order to use those higher pressure tube(s) to inflate the rest of the building.

21. The end cap of each tube is held in position and made gas proof by means of plastic or metal closure(s) and sealant.

22. If a puncture occurs for any reason the end cap can be removed and the internal gas barrier material repaired before resealing the tube and replacing it in the structure.

23. Inflation of the structure is achieved through (an) inflation valve(s) in a central node(s).

24. Deflation takes place from (a) sliding valve(s) situated in the apex central node.

25. Monitoring of the pressure can take place from one or more pressure gauges situated in central node(s).

26. Re-pressurisation can take place should a leak develop by means of a pressure switch connected to a pump.

27. The pump can be the main pump or can be a secondary pump.

28. The pump can be operated by Direct Current.

29. The pump can be operated by Alternating Current.

30. Alternatively the method of inflation can be by compressed air from a compressed air cylinder or directly from the compressor.

31. Alternatively some tubes can be inflated to a higher pressure at base, transported with the rest of the tent and inserted into the system of tubes whereupon the excess pressure is used to inflate all the other tubes to the correct pressure.

32. A further alternative method of containing the gas in each tube is by means of a non-return valve in both the socket and plug end of the quick-release connectors.

33. This ensures that no gas is lost when one end of the inflated tube is disconnected from the central node.

34. The diameter and length of inflatable tube determine the span of building.

35. The central node can accomodate different diameters of inflated tubes by means of a common quick-release connector.

36. Any length of tube can be substituted for another to increase or decrease the span.

37. Any diameter of inflated tube can be substituted for another to increase or decrease the span.

38. Different shapes of modules can be arranged singly by increasing or decreasing the length and/or diameter of inflated tubes relative to each other.

39. Said decrease or increase of length could be by way of example although not limited to, a method of leaning the outside arches inwards of outwards to change the shape of the building.

40. Said decrease or increase of length and/or diameter can be used to change the span and/or length of each module relative to each other in order to change the shape and/or dimensions of the building.

41. Each module can have attached to it by way of the central node an extension which when inflated becomes (a) bed(s), chair(s), table(s) and washstand frame(s) or clothes rail(s).

42. Each item of furniture can be added to or taken from the module before or after it has been deployed.

43. Each item can be deflated and packaged with or separately to the module.

44. Each module can have a number of different items of furniture at one time each inter connected or separate to one another.

45. The items are not limited to the above examples and could by way of example include bunk beds or double beds as well as single beds or as another example could form a dividing wall between 2

sections of the module or between 2 modules.

46. Said dividing wall(s) could be clad on both sides of the tube(s) to ensure greater privacy between sections of modules.

The invention will be described further, by way of example with reference to the accompanying drawings wherein:-

Fig. 1 is a perspective view of a complete 3 bay tent or modular building showing the outline of inflatable tubes;

Fig. 2 is a perspective view of that tent or building with front cover removed;

Fig. 3 is a perspective of the inflatable framework for that tent or building or a greenhouse;

Fig. 4 is the end view of a single inflatable arch;

Fig. 5 is the side view of a 3 bay module;

Fig. 6 is section B..... B of that 3 bay module, i.e. a central inflated arch;

Fig. 7 is section A.....A through the centre of the arches of the 3 bay module looking outwards;

Fig. 8 is detailed drawings of a side view of the central sections of an inflated arch;

Fig. 9 is detailed drawings of a side view of the outside sections of an inflated arch;

Fig. 10 is detailed drawings of A.....A of the central sections of an inflated arch;

Fig. 11 is detailed drawings of A.....A of the outside sections of an inflated arch;

Fig. 12 shows the method of increasing the length of a building

by adding another module;

Fig. 13 shows details of the method of fixing cladding to the modules;

Fig. 14 shows a method of altering the shape of a module by reducing the length of the two top horizontal inflatable tubes on the end modules;

Fig. 15 is an example of the method of incorporating furniture into a tent or building with inflatable tube connectors;

Fig. 16 is an elevation of a preferred arch of a further preferred building of the invention;

Fig. 17 is a plan view of a tubular frame structure of the building;

Fig. 18 is a side view of the same structure;

Fig. 19 is an end view of an arch/purlin junction;

Fig. 20 is a side view of such a junction;

Fig. 21 is a plan view of such a junction;

Fig 22 is a plan view of an apex /arch junction of the frame of the building;

Fig. 23 is a side view of the apex junction;

Fig. 24 is an end view of the apex junction;

Fig. 25 is an enlarged cross sectional view showing the junction of Figure 24;

Fig. 26 is a view comparable to that of 23 but showing the junction on an enlarged scale;

Fig. 27 shows further detail;

Fig. 28 shows an arched tube at a joint in cross section;

Fig. 29 shows an reinforcement sleeve used in constructing an arch;

Fig. 30 shows the sleeve after a first step has been performed;

Fig. 31 shows second and third steps of the process;

Fig. 32 shows fourth and fifth steps of the process; and

Fig. 33 illustrates in rather more detail the junction between an arched tube and purlin tube of the building of the invention.

In Fig. 1 is shown an outer cover or cladding (1) which can by way of example be canvas, PVC, a clear material such as Visqueen or Polyurethane AF such as is used in greenhouses or a combination of these and/or more substantial cladding such as aluminium sheets which are comparatively vandalproof. The cladding (1) has attached to it a front flap (2) which has within it a removable entrance split into two halves (3) & (4).

Within one half of the entrance is shown a window cover (5) and an opening through which can be seen 2 of the lower inflatable arches (10) & (11) that are part of the inflatable framework.

The cladding (1) can be joined to the inflatable framework and the entrance by means of a touch-and-close fastener such as Velchro as shown at (7) & (8) and the entrance can also be closed by the same means as shown at (6).

A dotted outline of the 2 other inflatable arches are as shown as (9) & (12).

In Fig. 2 a more detached perspective view is shown of the building, tent or greenhouse whereby the inflatable arches (9) (10) (11) & (12) are clearly seen together with the horizontal tubes (14)

(15) (16) (17) & (18) that form the complete inflatable framework. Also shown are the back removable cover (13) and the side cladding (1) joined by way of example to arch (9) at (7).

Fig. 3 shows the complete inflatable 3 way structure without cladding whereby the 4 arches (9) (10) (11) & 12 are joined to the horizontal tubes (14) (15) (16) (17) and (18) by means of connection systems on the outside (25) (26) (27) (28) & (29) and by central connection systems (30) (31) (32) (33) & (34).

The four arches illustrated (9) (10) (11) & (12) each consist of 4 inflatable tubes (20) (21) (23) & (24) and all connection systems (25) (26) (27) (28) (29) (30) (31) (32) (33) & (34) have a similar connection node (22)

In Fig. 4 a single outside arch (9) is shown in greater detail whereby inflatable tubes (20) (21) (23) & (24) all have end caps (38) which are fixed in position by means of jubilee clips or some other retaining system (41) and are sealed by means of an adhesive (not shown) between the inner gas barrier (not shown) and the end cap (38).

Each end cap (38) whether for horizontal or vertical tubes has a quick-release connector plug (46) as shown in Fig. 12 which is plugged into its corresponding quick-release connector socket (37) as shown in Figs (4) (5) (9) (11) & (12).

The quick-release socket (37) is preferably attached to the central node (22) in order that the non-return valve (45) as shown in Fig. 11 can prevent any gas escaping when an inflated vertical tube (20) (21) (23) (24) or horizonrtal tube (14) (15) (16) (17) or

(18) has to be detached. Alternatively a further non-return valve (45) could be inserted in the quick-release connector plug (46) as well or in place of the quick-release socket (37) to ensure that the tubes(s) did not leak gas when removed. Together the socket (37) and plug (46) form the quick-release connector (39) and the central node (22) has a common gas channel connecting quick-release connectors (39) and other attachments such as an inflation valve (36) pressure gauge (42) gas exhaust valve (43) or extension tubes (54) (55) as shown in Fig. 15 depending upon the position of the node (22) in the arch (9) (10) (11) or (12).

If no attachment is required in the node (22) a blanking plug (44) is used to seal it off at that point.

In Figs. 4 & 6 a Section A.....A is drawn to enable a view to be taken looking towards the right in Figs. 7 10 11 & 12 through the centre of the structure. In Fig. 5 a section B.....B is drawn to show in Fig. 6 how the structure would appear again looking to the right. Fig. 4 is primarily showing a more detailed view of connector (25) (28) & (29) whereas Fig. 6 shown connectors (31) (33) and (34) from an end view.

Fig. 8 shows connectors (30) (32) & (34) whereas Fig. 9 shows (25) (27) & (29) both from a side view and finally Fig. 10 shows connectors (30) (32) & (34) whereas Fig. 11 shows connectors (25) (27) & (29) through section A.....A.

Fig. 7 shows the section A.....A through 4 arches (9) (10) (11) and (12).

Stand (19) is shown in all the detailed drawings with a stand

node (35) connecting it to the central node (22). Fig. 10 shows a cut away section of connectors (34) with the quick-release connectors (50) end caps (38) exhaust valve (43) and jubilee clip (41). Fig. 11 also shows the non-return valve (45) quick-release connector socket (48) whilst quick-release connector plug (47) is also shown more clearly in connector (29).

Fig 12 shows the method whereby the 3rd arch (9) is connected to the second arch (10) by means of the quick-release plug (46) in the end cap (38) of horizontal tubes (14) (15) & (16) being pushed into socket (37).

(47) & (48) are the cut away views of quick-release socket (37) and quick-release plug (46) respectively.

Fig. 13 is shown as one example of how a touch-and-close fastener such as velchro or Cric-crac would be attached to the inflatable tubes where (7) is the fastener on the vertical tubes (20) & (21) and (51) is the fastener on the horizontal tubes (14) (15) & (16).

Fig. 14 demonstrates how by shortening tubes (15) & (16) to become (15a) and (16a) the side view changes shape.

It also has other differences in that the angle of (15a) and (16a) differ from (15) & (16) although (14) remains constant in length and angle. To allow for the difference in angle to tubes (15a) and (16a) the connectors (25a) (27a) (29a) (32a) & (34a) all have to have their node connectors (22a) drilled and tapped at a different angle on one side to accommodate the quick-release connector (37a) in order for it to be at the correct angle.

Tubes (20) & (21) remain the same length or alternatively in arch (9a) & (12a) could be lengthened so that tubes (15a) and (16a) would remain horizontal rather than slope downwards.

Fig. 15 shows a 3 module tent or building from the front end without any cladding in which a bed (52) and chair (53) are connected to arch (10) and (12) through a connection tube (54) and (55) respectively. The bed (52) and chair (53) are constructed in exactly the same manner as the building itself in that they have a stand (19a) and quick-release connectors (39) with inflatable tubes (56) which can be inflated and deflated together with or separate to the main building.

Equally well there could be a partition (now shown) from connectors (32) to (33) either with a single or double wall or as a further alternative an inflatable rail (not shown) could be taken across from connectors (32) to (33) to act as a clothes rail.

If inflatable rails were also taken between all the other connectors at eave height it would be possible to put in a single or double skin false ceiling (not shown) to increase thermal protection.

Although Fig. 12 shows a 3rd module consisting of tubes (20) & (21) with horizontal tubes (14) (15) & (16) being added to arch (10) the number of arches or modules is not limited, nor is the length of each individual tube and the high usable pressures that are possible because of the method of construction of the individual tubes allow much greater lengths of tubes than is possible by normal inflatable tube systems which are only capable of sustaining a pressure of 2-5 PSI compared to these tubes which are capable of being inflated

to greater than 200 psi.

The node (22) can be manufactured from aluminium or alternatively a plastic injection moulding could be produced. Each attachment whether a quick-release socket (37) or stand connector (35) can be screwed into the node (22) with a common threaded size or with an adapted (not shown) if required.

The inflation valve (36) can be connected to a pressure switch (not shown) which monitors any leakage of gas and replaces it by means of a pump (not shown) once it reaches a critical level.

By way of example should the pressure normally be kept at 75 psi the pressure switch would allow it to leak to 55 psi before switching on the pump to bring it back to 75 psi, but the maximum and minimum safe working pressure can be adjusted according to requirements.

When a touch-and-close fastener is used such as Velchro (7) (8) & (51) it is possible to pre-tension the arches (9) (10) (11) & (12) against the outer covering (1) (2) when deflated so that on inflation the velchro (7) (8) & (51) becomes very difficult to peel off wheras it is simple when deflated.

Although the preferred gas is air many other gases could be used such as CO2 or Nitrogen and instead of being filled with a gas the structure could be filled with foam to make a more permanent structure, but if used in this way it would not be deflatable and foldable like the preferred method of filling with air.

Although the vertical tube angle of connectors is set at 135° in the preferred method of construction any angle could be used to

increase or decrease the span and eave height. The preferred method of deflating and folding the building, greenhouse or tent depends on the outside cladding, but if it is a flexible material each module or a number of modules could be rolled up from the bottom of the deflated tubes as depicted in Fig. 7 at (25) (30) after removing stand (19) but together with the canvas or other cladding as shown in Fig. 1 by (1) either on its own or with ends (2) & (13) as shown in Fig. 2 respectively at tubes (20) (21) and deflated horizontal tubes (14) (15) would be rolled up towards the top and top horizontal tubes (16) and connectors (29) (34)

The opposite side of the building or tent would likewise be rolled up from horizontal tubes (18) and connectors (26) and (31) towards the apex and then folded inwards from connector (29) towards the centre. Instead of folding a number of modules together it would be possible to detach each module from another and fold it individually but the choice would depend amongst other things on the span, number of modules and weight of cladding (1) (2) & (13).

Alternatively if the cladding is a rigid material such as aluminium or rigid plastic it could be attached to the inflatable horizontal and vertical tubes by means of velchro or some similar type of touch-and-close fastener (7) (8) and when deflating the module each sheet of aluminium or other rigid material could be detached individually before folding up the deflated frame.

The invention is not limited to the precise details of the foregoing, and variations can be made thereto.

Although the examples given of furniture which could be incorporated as part of the tent or building are beds and chair this invention is not limited to those items and by way of example a bookshelf and/or table and/or washstand frame could be incorporated.

Another example of a variation is to use a simple air line connector between the furniture (52) & (53) and/or dividing wall (now shown) rather than inflatable tube (54) & (55).

Many other variations are possible within the scope of the invention.

Referring now to Figs. 16 to 24 it will be seen that a second preferred embodiment of building of the invention has a frame work made from four arches and three purlins. The building can cover any convenient area, but that disclosed has a length of 6 metres and a span of 6 metres. The three purlins are disposed one at each angle in the arches, namely two at the eaves and one at a ridge. Competent engineers will realise, of course, that a hermispherical or comparable shape would be far stronger and have greater resistance to bending and wind pressure. However, a hemispherical shape gives reduced usuable area due to the sloping nature of the walls, and gives rise to a structure which has a shape which is psychologically unpleasing. Firstly the shape is rather reminiscent of such cheap utility buildings such as nissen huts and, secondly, does not resemble a conventional building. Users are psychlogically far happier with a building which has a general rectangular shape reminiscent of conventional housings of conventional construction.

Each arch 61 has two wall portions 67 and two roof portions 68. Generally, each arch 61 and purlin 62, 63 is manufacutred in accordance with the methods given in the above described PCT Applications or in my above co-pending Applications as will be described later the tube consists of an inner inflatable envelope of air permerable material and an outer sleeve of tough reinforcement material, the two being adhered together to form a flexible inflatable tube. This construction will be discussed later in connection with the angled constructions.

Figs. 17 and 18 illustrate how the purlins and arches are viewed in side and plan view and are self explanatory. As will later be described in detail, each junction between an arch and an purlin includes a strapping arrangement which unites the two. Figs. 19, 20 and 21 illustrate the shape and configuration of the junction 69 between an arch 61 and eave purlin 62. It will be seen that there can be a gasflow connection shown at 70 for inflation/deflation purposes. Figs. 22 to 24 illustrate a junction 71 between the arch 61, its ridge angle 66 and the ridge purlin 63. Again a gasflow connection 72 can be provided. Strapping arrangements at these junctions will be described in detail later.

STRAPPING JUNCTION

Each arch 61 is formed with one or more angles and a purlin can be disposed at each angle. Figs. 25 to 28 illustrate an eaves junction 71 between an arched eave angle 65 and a ridge purlin 63. The strapping serves to hold the two components closer together so

that they can transmit forces one to the other but significantly without any relative movement which could cause abrasive wear. In addition, the strapping also exerts forces on the angle 65 which tends to restrain it against returning towards a straight configuration under its own internal pressure. A distance is spaced from the apex 73 of the angle 65 with encircling bands 74 which are adhered or otherwise secured to the arch 61 and serve as anchorages for straps. In a similar manner the purlin 63 is provided with an encircling band 75 right at the junction. Main tensioning straps 76 are anchored one to each band 74 and has its free end engaged with fastener 77 fixed to the band 75. Secondary straps 78 each of which is again anchored to the band 75 and has its free end attached to a fastener 79 attached one to each band 74.

As I mentioned, the straps 76 are the major uniting straps, and the tension straps 78 serve to prevent the purlin 63 from rocking relative to a point round about 80 and possibly rubbing against the arch. The tension straps also tends to reduce the possibility of either tube making too much of an impact into the other so as to weaken its profile, as well as contributing to force which tends to hold the arch in its angled configuration.

Of course, many other configurations of strap can be used and the various positions of the fasteners and the anchorages can be reversed without any loss of function. The postions of the various straps and the bands is shown in a little more detail in Fig. 33. The straps can be of webbing or of any other convenient material compatible with the material of the tubes.

ANGLE FORMING

Figs. 29 to 32 illustrate how an angle, such as the angle 65 or 66 can be formed in the tube which constitutes an arch 61. As will be apparent from the aforementioned earlier specifications, each of the tubes making up the arches and purlins is constituted by an internal air impermeable inflatable envelope which is disposed within an exterior sleeve of flexible reinforcement material which can be a heavy weight reinforcing fibre or other web of ligaments. Adhesive unites the two to form the tubes on which the arches and purlin are made.

Fig. 29 shows a sleeve 81 of woven reinforcement material such as kevlar or heavy duty nylon. In forming an angle 65 the sleeve 81 is first bent to the required angle. This produced undulations or creasings 82. Fig. 31 illustrates a desirable but not essential step in the creation of the angle 65. A former 83 on a support 84 is introduced into the sleeve 81. The former 83 is shown as an inflatable former and such a former is easiest to handle. However, a smooth solid or incompressible former can be used provided that it has a suitable anti-friction coating and can be removed from the angle after construction. A loss former can be used but tends to increase the weight and bulkiness of the folded framework and therefore is not considered really suitable. There may, however, be circumstances where a loss former could be used, for example a foamed plastics material.

The material of the sleeve is chosen so that it shrinks to a

certain degree upon the application of heat. Here it should be stressed that the degree of shrinking should be relatively small, and that the strength of the material should not be significantly degraded due to the shrinking. The afore-mentioned earlier specification discussed several material which have this property. Subsequent to forming the sleeve into the angle and with or without the former (preferably with the former) heat is applied to the creases 82 to cause shrinkage of the sleeve material on the interior of the angle 65. As will appreciated, there is most creasing adjacent the apex 73. Accordingly, most heat is applied adjacent the apex and progressively lower amounts of heat along the sleeve 81. Heat is conveniently applied by means of infra red heating means 85 which apply greatest radiation against the apex unless along the rest of the tube. This causes the sleeve to shrink on the interior of the angle to the shape shown in Fig. 32.

Here it should be mentioned that instead of a heat shrinking process a solvent (in the case of an appropriate material for the sleeve) or a process in which shrinking takes place under the effect of radiation other than heat, for example ultra violet radiation could be used. In each system it is, of course, important that any loss of strength in the sleeve is not significant or can be easily compensated.

If desired as reinforcement, or if the nature of the sleeve shrinkage has been such that reinforcement is neccesary, a strengthening band 86 can be applied to the inside of the angle by means of adhesive or sewing. After this step an internal envelope

87 of gas impermeable material is introduced into the interior of the reinforcement sleeve 81. Adhesive applied to the exterior of the envelope and/or in the interior of the sleeve is activated upon inflation of the envelope to cause the two to be securely united. It has been found unneccesary to treat the internal inflatable envelope to cause it to take the shape of the bend. It has been found that the material is sufficiently flexible to crinkle in the manner illustrated at 88 and accommodate the bend without any significant loss of strength or likelihood to deform or fail. If desired, during the inflation and adhesion/curing phase the angle 65 can be surrounded by an external mold or restraint to discourage the sleeve from being straightened by the internal pressure in the envelope.

It will appreciated that the angle through which the sleeve is to be bent can be chosed at well within quite a wide range. In the case of greater angles, it may well be that the amount of heat shrinkage in the material is insufficient to clear the amount of loss of length which is required. In these cases it may be necessary to effect a degree of cutting out, sewing or folding of the material of the sleeve as a supplement to the essential shrinking step.

The building of the invention can be provided with sheathing in the form of a horning which overlies the framework, or which is suspended within the framework from fasteners secured to the arches and/or the purlins. For insulation purposes, there can be both internal and external sheaths. The sheath(s) can be provided with appropriate doorways with sliding clasp or other convenient fasteners.

It will be appreciated, of course, that lower end of the arches

will be secured to feet either directly to the ground or to a specially prepared base as described in relation to the first embodiment.

Of course, the shape of the arches and the number and the shape of the purlins can be varied as well.

It is desirable that the diameter of the purlin is equal to or greater than the diameter of the arch and, if the two are of equal diameter that the pressure within the prlin is at least equal to the pressure in the arch. We have found that if, at a junction such as 71, it is important that the purlin is not deformed in any way. If it is, it tends to lose strenght and form a weak point. However it has been found that the arch can be deformed to a certain extent without significant loss of strength and therefore the arrangement between the two should be such that the purlin is at least equal to the strenght of the arch. As a greater diameter is stronger than a small diameter tube this is one way of achieving this with equal pressures. With equal diameter tubes, the purlin should really have a greater pressure than the pressure in the arch. However, as a common inflation is desirable, this cannot always be achieved. Therefore a purlin of 470mm circumference can ideally be used in combination with an arch of a circumference of 395mm.

Many other variatons are possible within the scope of the invention.

CLAIMS

1. An inflatable building including a plurality of arches each constituted by an inflatable tube structure and purlins interconnecting said arches.

2. A building as claimed in claim 1 wherein each arch is a single inflatable tube with bends or a plurality of individual tubes joined together.

3. A building as claimed in claim 2 wherein the joints are effected by end caps provided with hinges which connect the tubes.

4. A building as claimed in claim 2 wherein each arch is made from a continuous tube, the tube having been made from an inner envelope of air impermeable expansible material disposed within an outer sheath of reinforcement material, the two having been urged into contact and adhesive used to secure the two together.

5. A building as claimed in claim 4 wherein each joint is made by manufacturing a straight tube of reinforcement material treating the tube at a desired joint position so that walling of the tube on one side becomes shorter than walling on the otherside and disposing the inflatable envelope within the tube and inflating it to contact and become adhered to the reinforcement.

6. A building as claimed in claim 5 wherein to form the bend in the outer cylindrical shell, walling on one side is shrunk and/or walling on the other side is expanded.

7. A building as claimed in claim 6 wherein one side of the walling is shrunk only.

8. A building as claimmed in claim 7 wherein shrinking is effected

by radiation or solvent.

9. A building as claimed in claim 7 wherein shrinking is effected by heat. .

10. A building as claimed in claim 7, 8 or 9 wherein to aid forming an elbow-shaped piece is disposed within the reinforcement.

11. A building as claimed in claim 10 wherein the elbow is inflatable and deflatable.

12. A building as claimed in claim 10 or 11 wherein the step of creating a joint is effected prior to the addition of end caps.

13. A building as claimed in any preceding claim wherein the purlins are attached by having joints which hinge to the arches.

14. A building including a plurality of arches and a plurality of purlins, each arch being in the form of an inflated tube having one or more angles, at least one purlin bridging two or more arches and being connected at corresponding angles of the arches.

15. A building as claimed in claim 14 wherein the purlins are connected by strapping to the tubes.

16. A building as claimed in claim 15 wherein the strapping is such as to resist un-bending of the angle under the inflation pressure within the tube.

17. A building as claimed in claims 14, 15, or 16 wherein purlin diameter is equal to or greater than the tube diameter.

18. A building as claimed in any preceding claim wherein each tube is terminated by a plastic, metal or fabric end cap.

19. A building as claimed in claim 18, wherein the cap can incorporate a quick release connection.

20. A building as claimed in claim 19 wherein the quick-release connection is a plug.

21. A building as claimed in claim 19 wherein the quick-release connection is a socket and gas is prevented from entering or leaving the tube by a non return valve which can only be de activated by the insertion of the plug section of the quick-release connection.

22. A building as claimed in claim 20 or 21 wherein the other end of the quick-release connection (plug or socket) can be connected to a central node.

23. A building as claimed in claim 22 wherein the central node has a plurality of interconnected tubes which allows other connectors, instruments and valves to be screwed into or otherwise fixed to the node.

24. A building as claimed in claim 22 wherein the central nodes provide a central connection between vertical and horizontal tubes and can also be connected to a footwell or other means of pinning the inflated building to a base or the ground.

25. A building as claimed in any preceding claim, wherein an outer membrane overlies the framework or is hung beneath it.

26. A building as claimed in claim 25 wherein the membrane is mounted by means of touch-and-close fasteners.

27. A building as claimed in any of claims 1 to 24 wherein an extruded plastic or other more substantial and rigid material is affixed to form a more permanent enclosure.

28. A building as claimed in claim 24 to 27 wherein the cladding attachment to the inflatable tubes is tensioned by inflation of the

tubes making it difficult to remove until deflation.

29. A building as claimed in any preceding claim wherein an individual tube is adapted to be removed from the building without allowing gas to escape from the rest of the tubes.

30. A building as claimed in claim 23 wherein if a socket end of the quick-release mechanism is affixed in each tube rather than the node all other tubes connected to that node must be detached, it being possible to pre-pressurise one or some of the tubes of building to a higher pressure than that required by the tent or building when it is deployed, in order to transport it/them with the rest of the tent or building to site in order to use those higher pressure tube(s) to inflate the rest of the building on site.

31. A building as claimed in claim 16, wherein end caps of each tube are held in position and made gas proof by means of plastic or metal closure(s) and sealant.

32. A building as claimed in claim 30 wherein inflation of the structure is achieved through (an) inflation valve(s) in a central node(s).

33. A building as claimed in claim 30 wherein monitoring of the pressure can take place from one or more pressure gauges situated in central node(s).

34. A building as claimed in any preceding claim wherein one or more arches has an internal fitting attached and inflatable therewith.

35. A building as claimed in claim 34 wherein the fitting is a bed, chair, table, washstand, frame or clothes rail, or a dividing wall or partion.

36. A building substantially as described with reference to the drawings.

37. A method of making an inflatable building including creating a framework including a plurality of inflatable tubular arches each having sections which join at angles, uniting the arches with inflatable purlins at selected ones of the angles, connecting the purlins to the arches at angles and supporting a membrane by the framework.

38. A method as claimed in claim 37 wherein each arch is in sections joined at the angles.

39. A method as claimed in claim 37 wherein each arch is continuous each angle being formed by creating an elbow in the material of the arch tube.

40. A method as claimed in claim 37, 38 or 39 wherein the arches and purlins are united by tension members.

41. A method as claimed in claim 40 wherein the tension members are straps.

42. A method of making an inflatable building substantially as described with reference to the drawings.

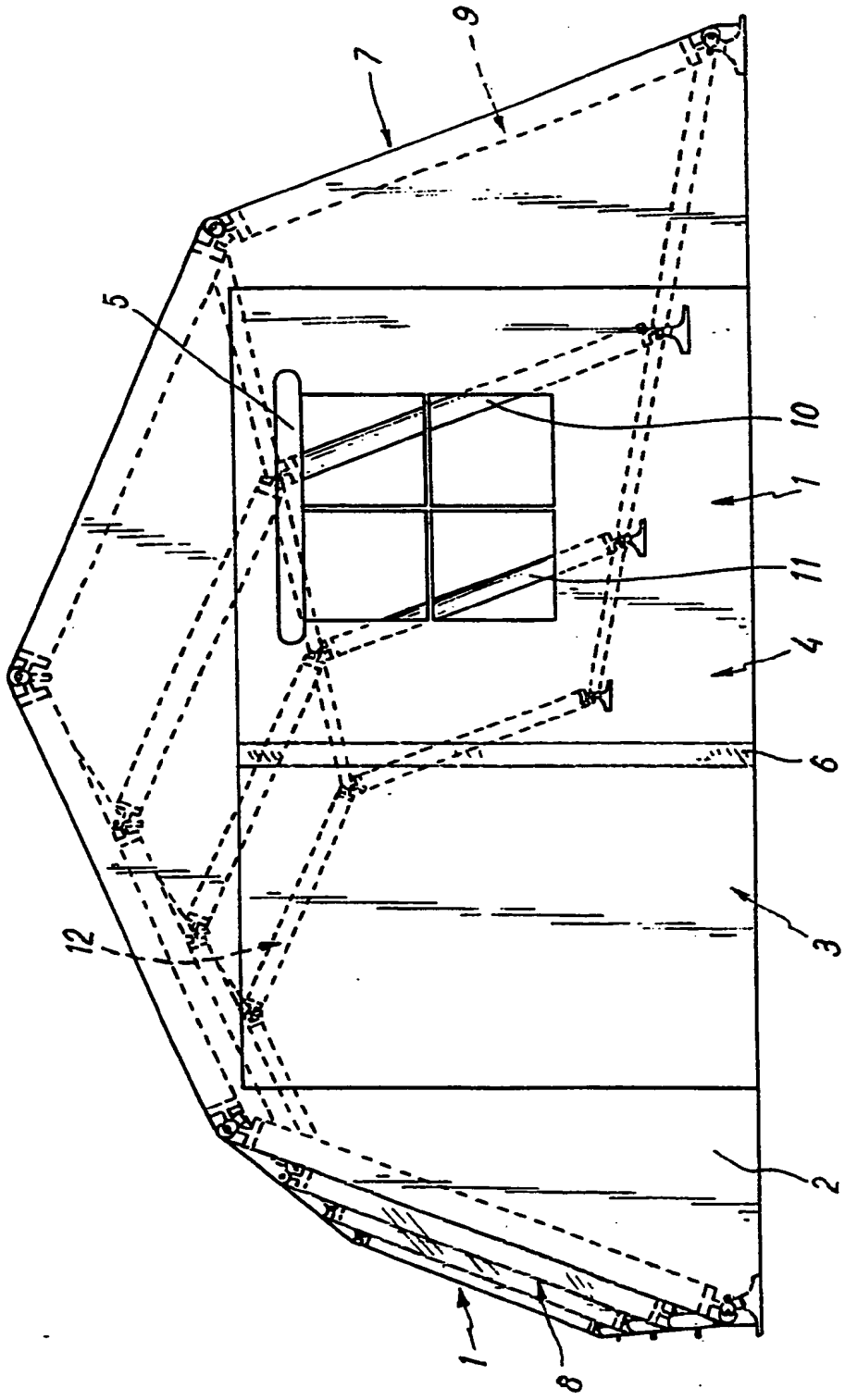

FIG. 1

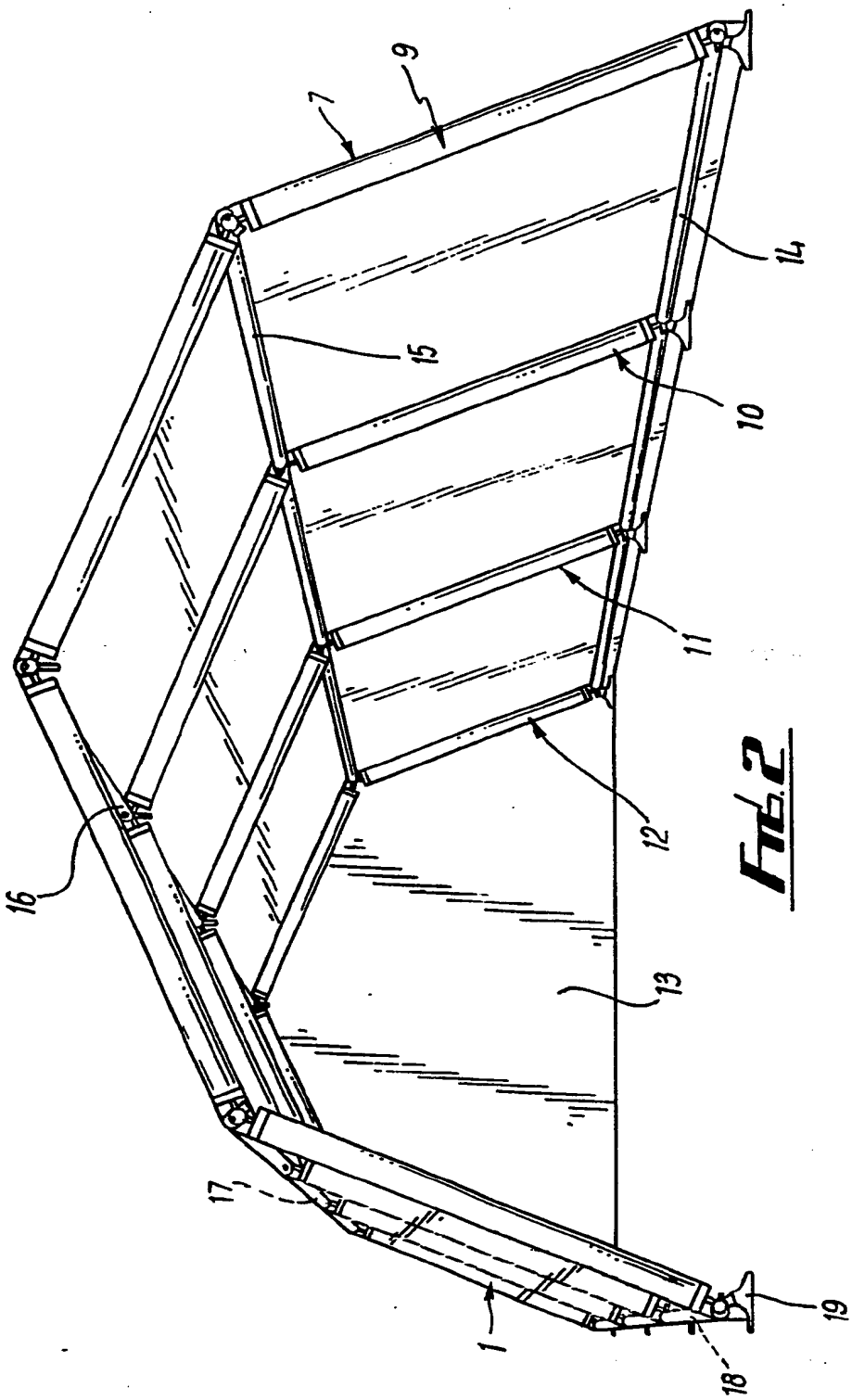

FIG.2

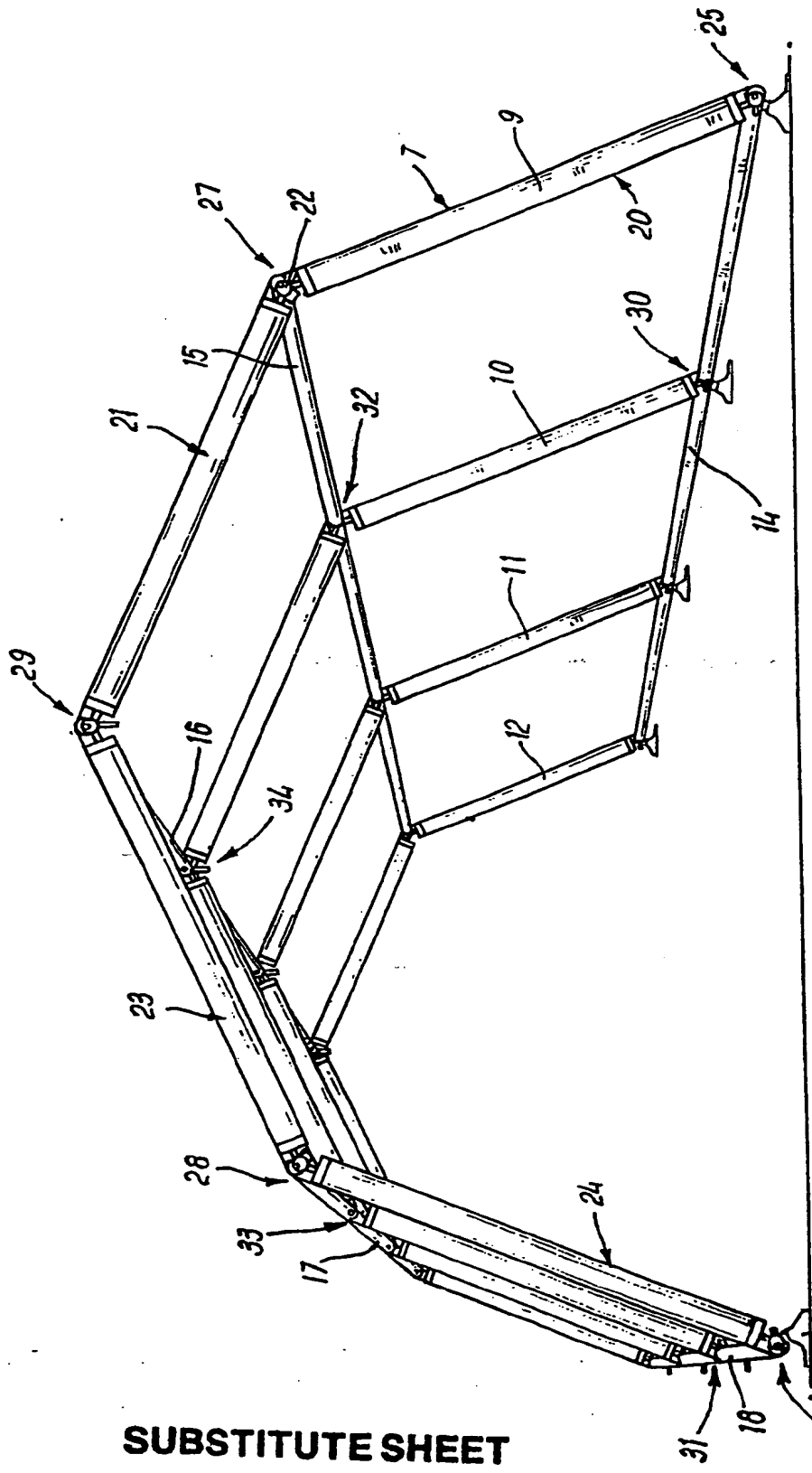
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FIG. 3

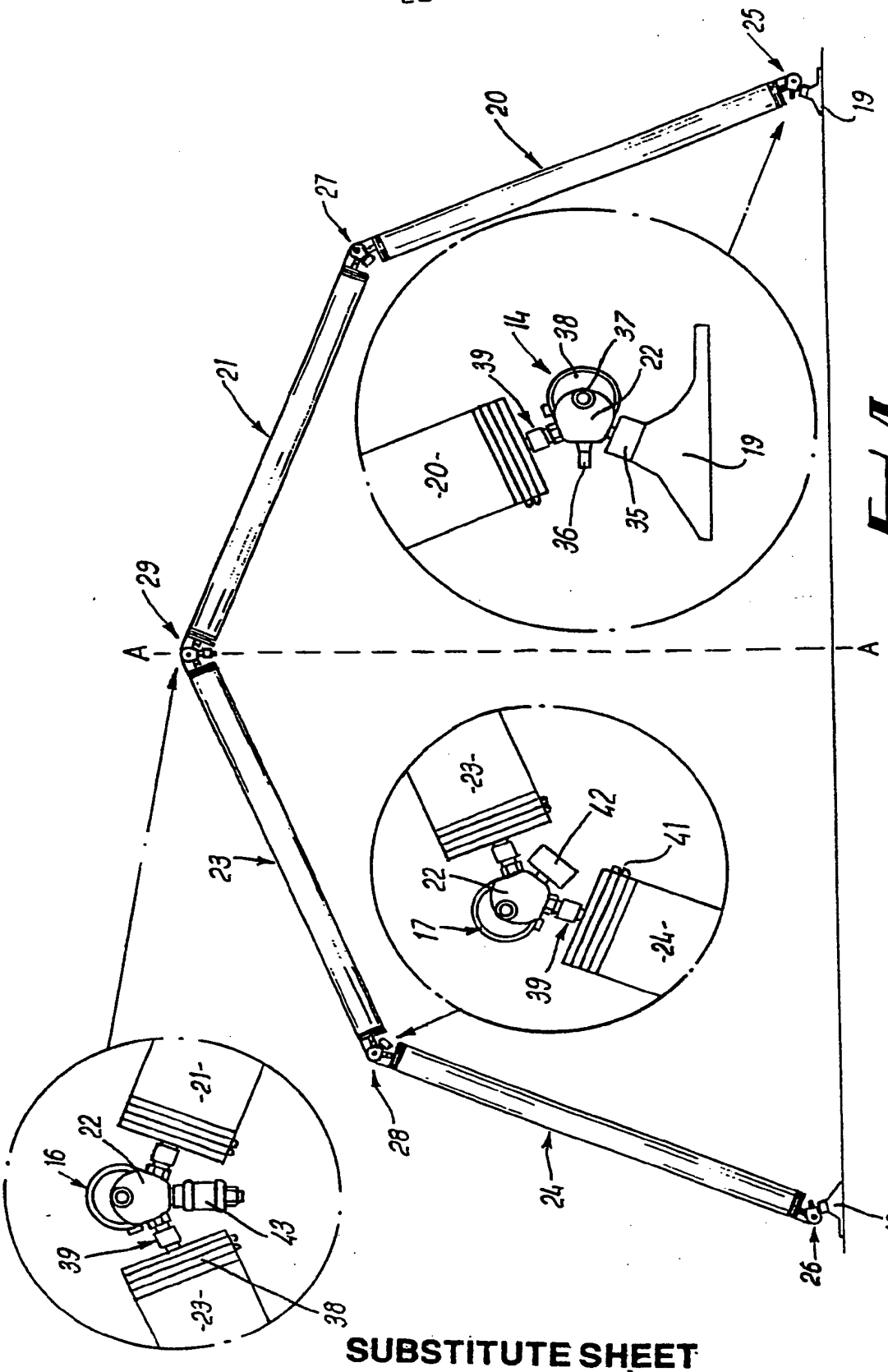

FIG. 4

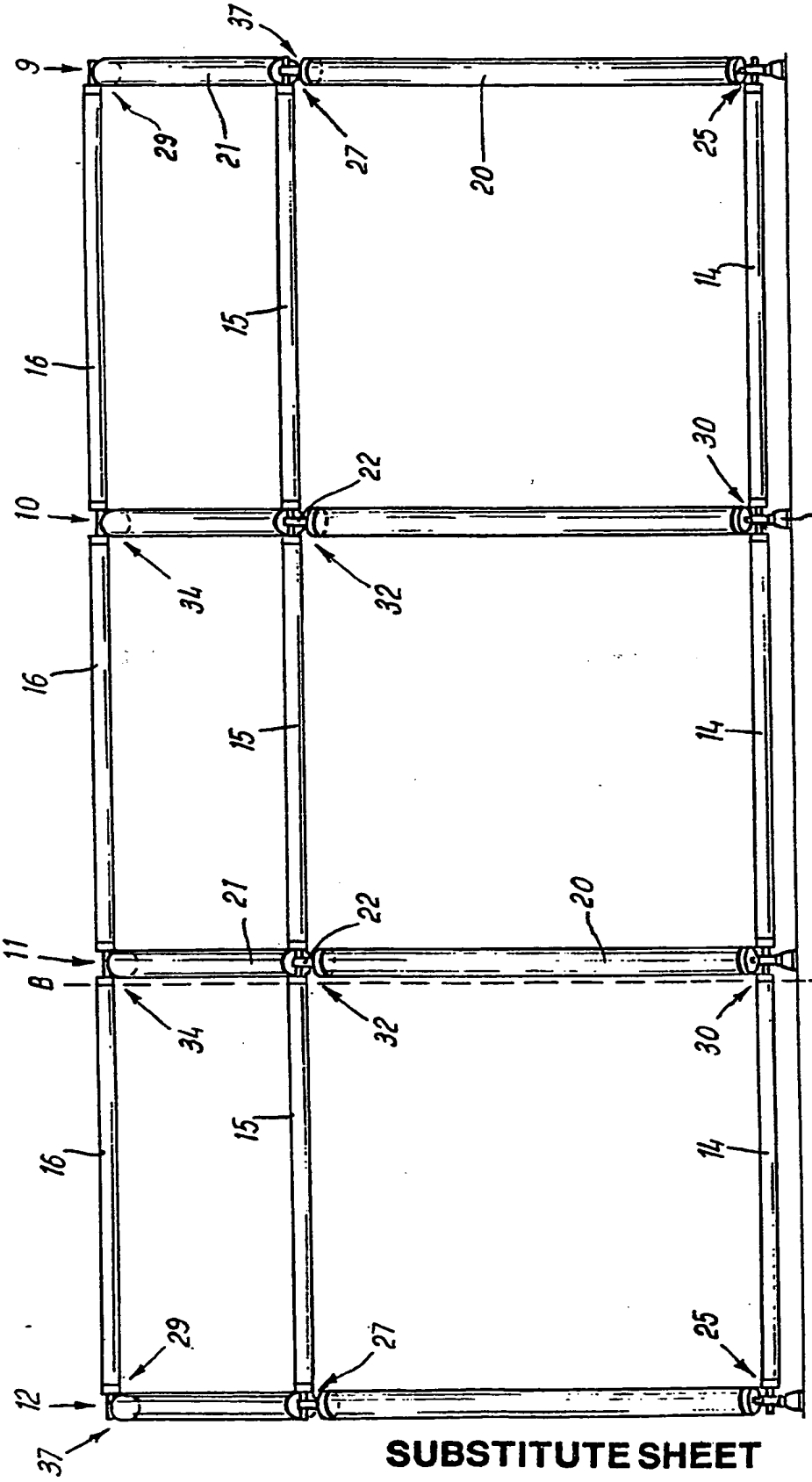
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FIG.5

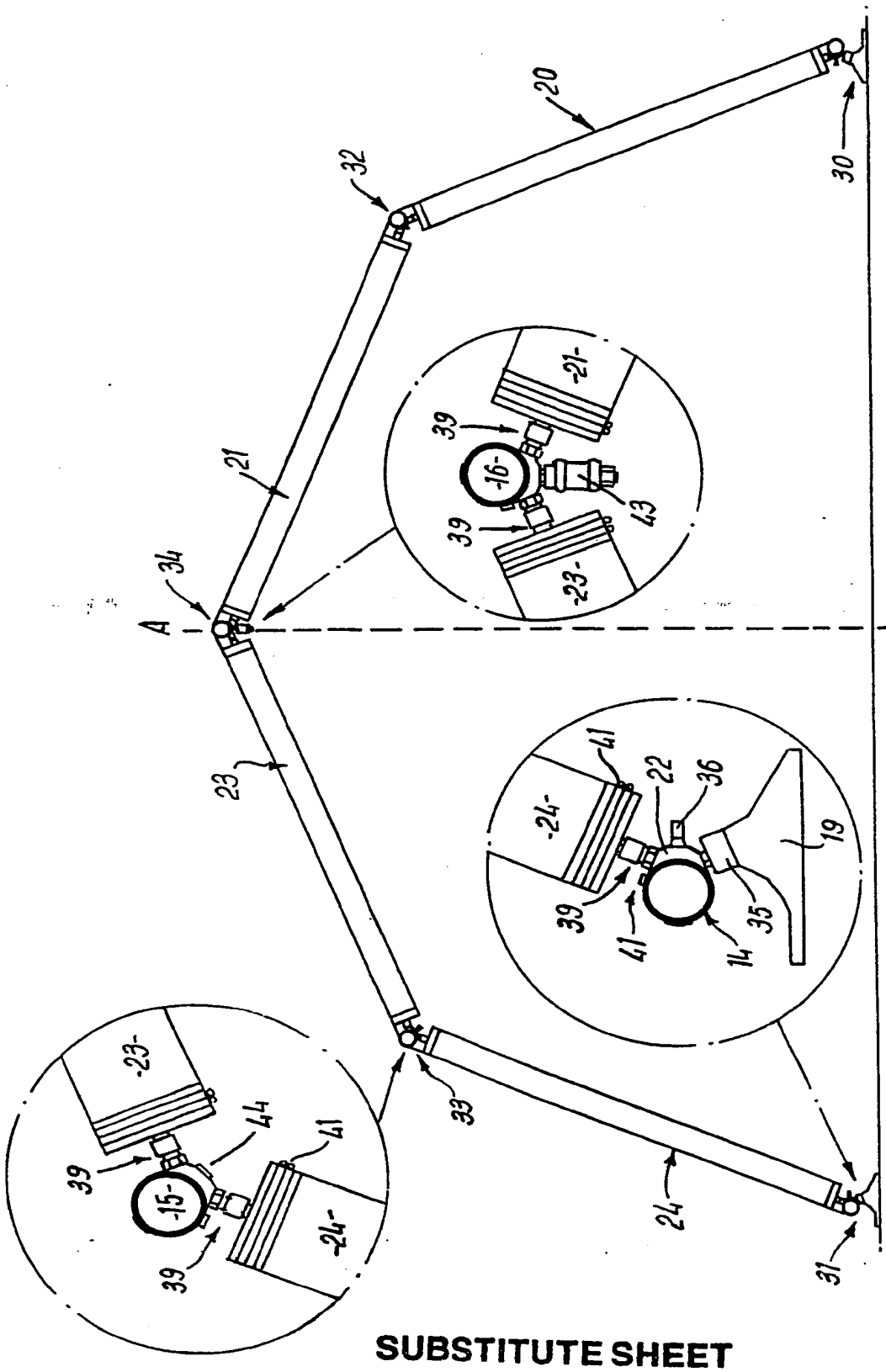

FIG. 6

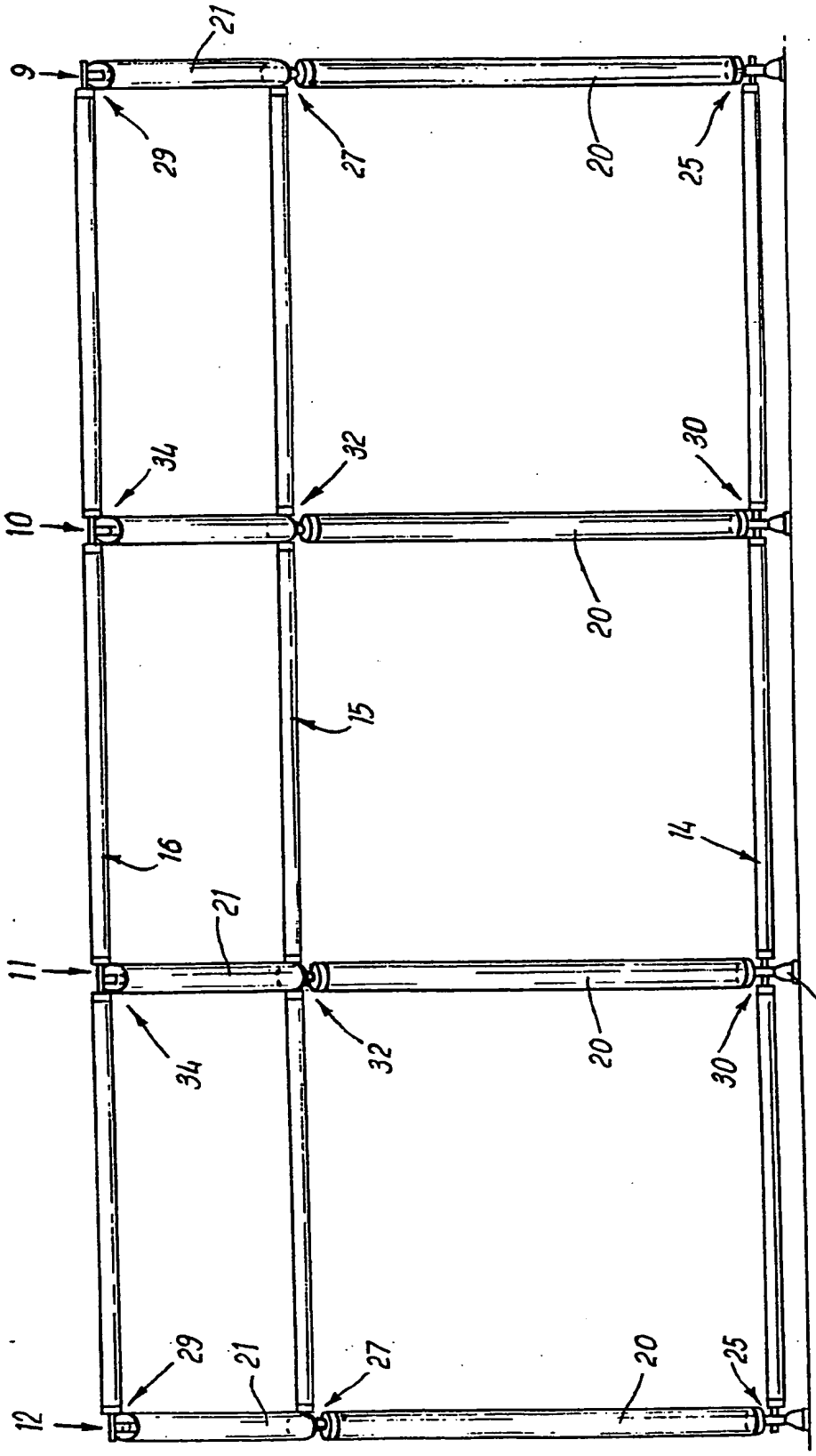

FIG. 1

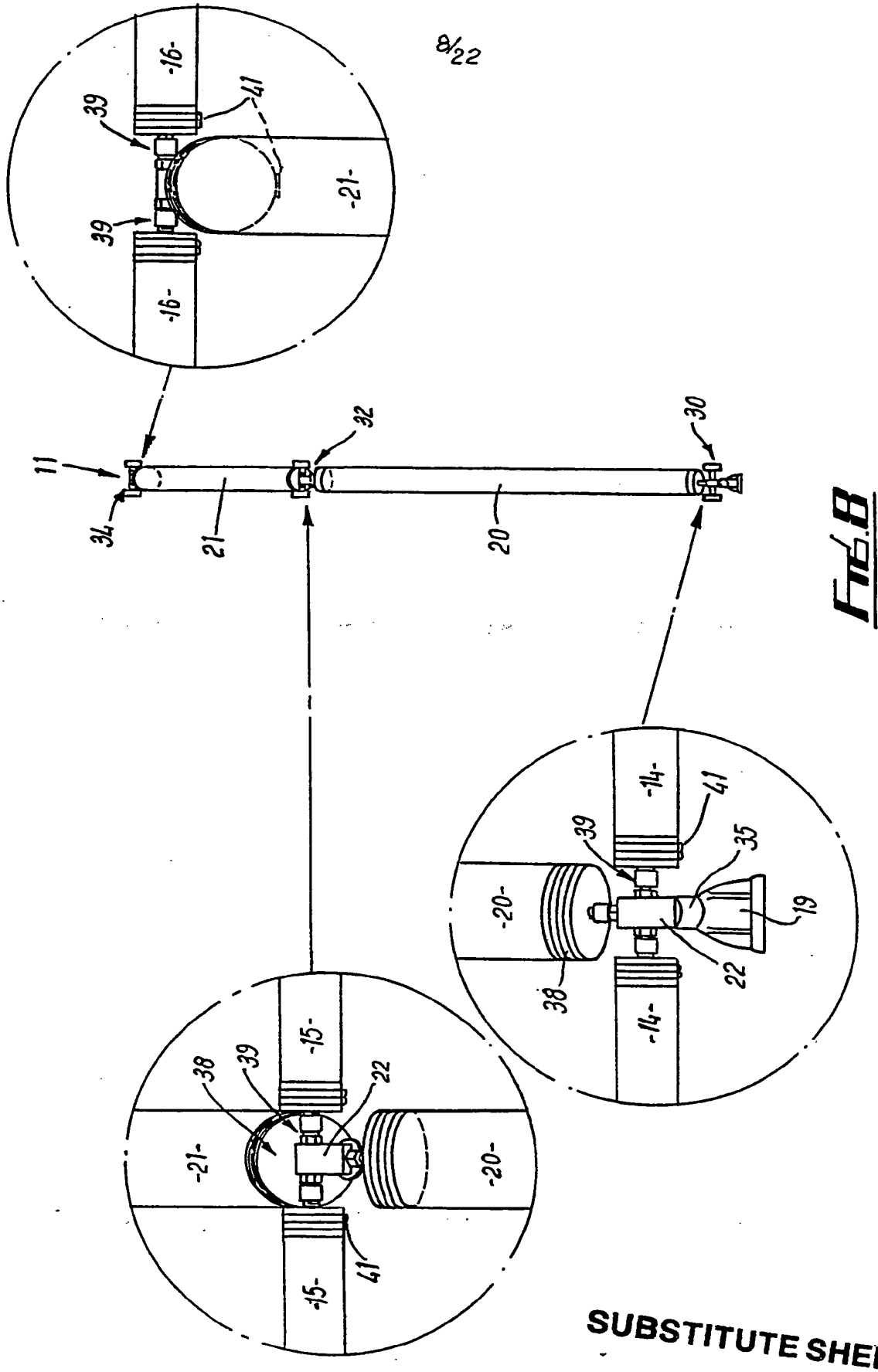
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FIG.8

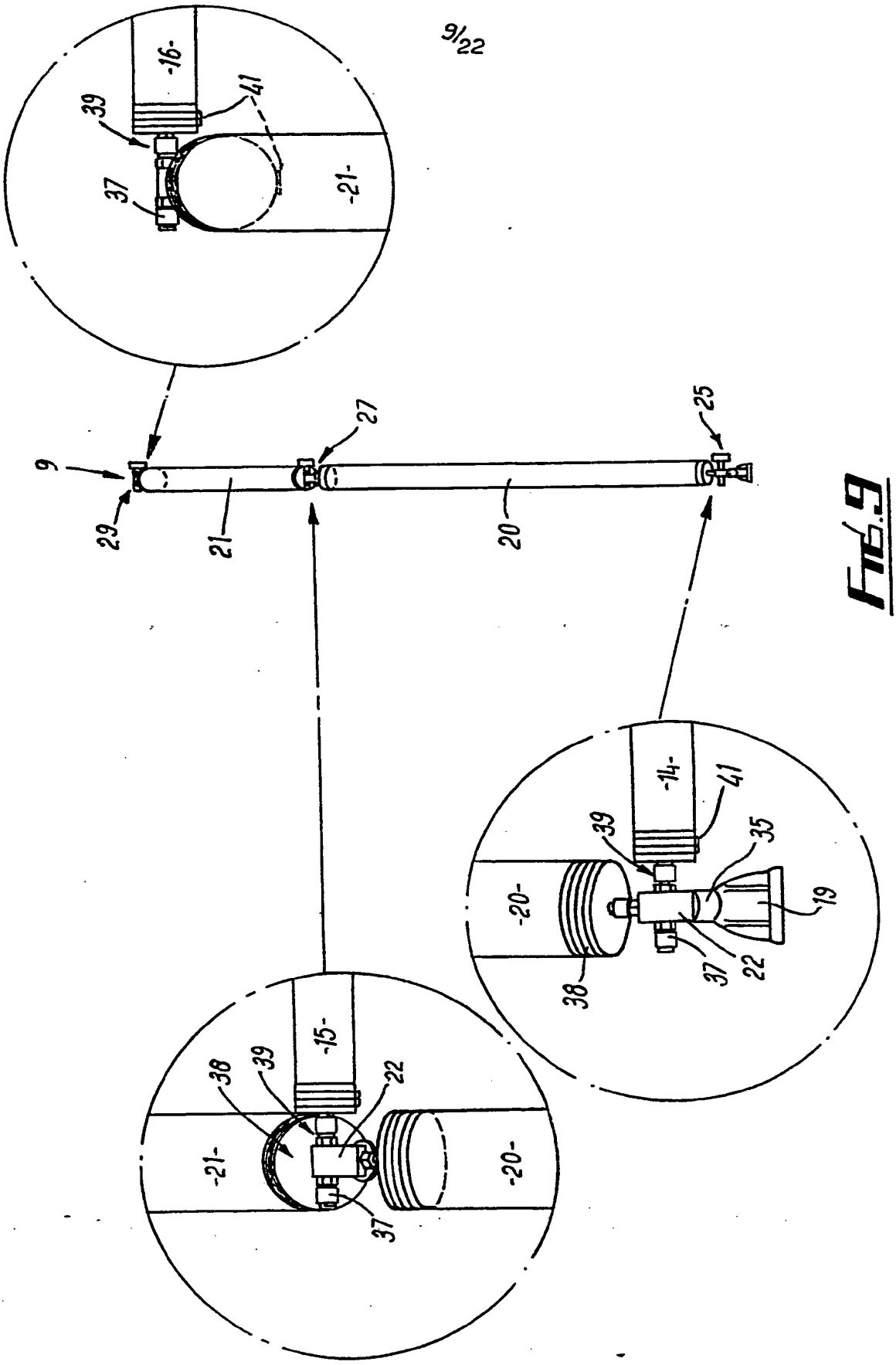
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FIG.9

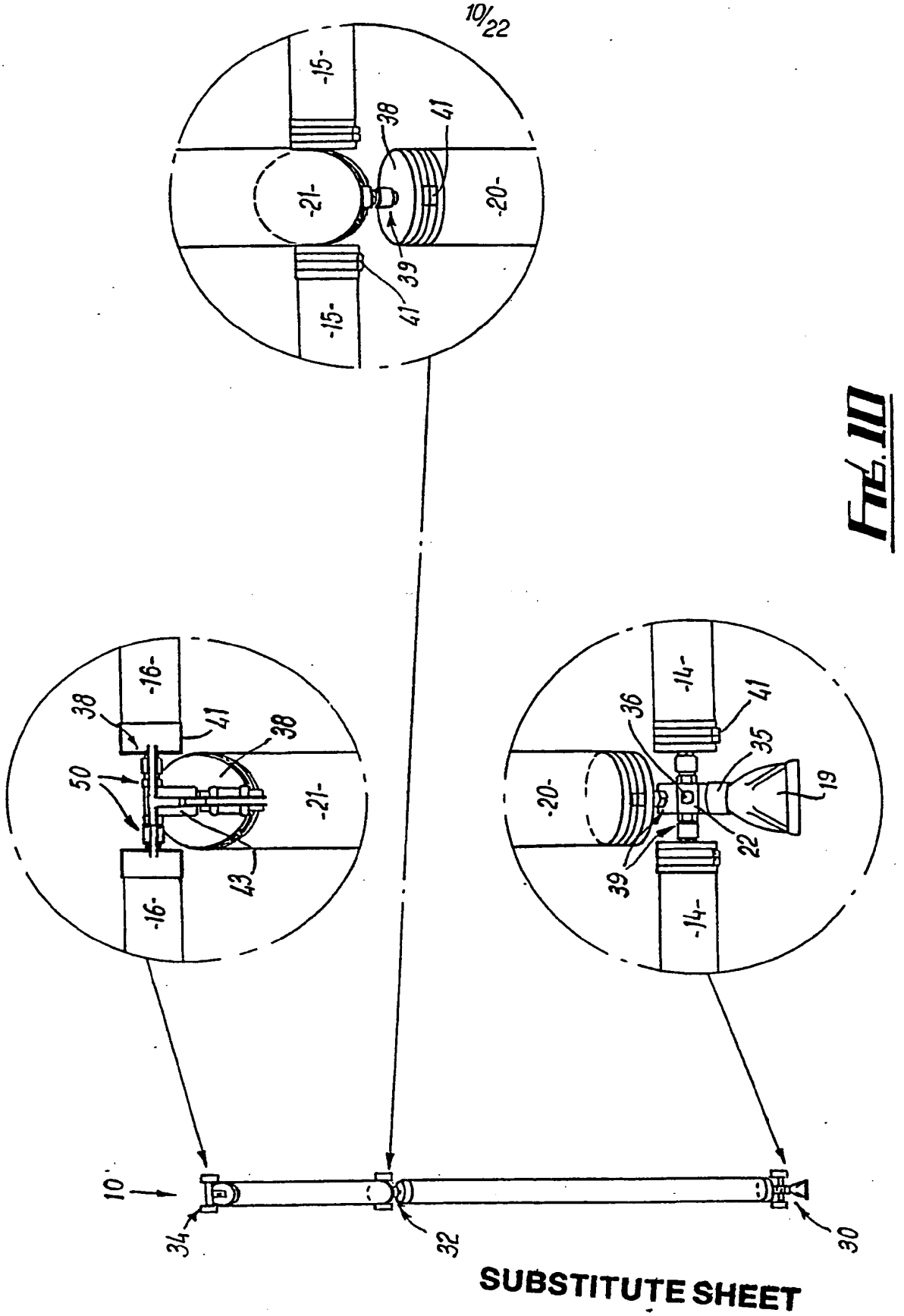
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Fig. 10

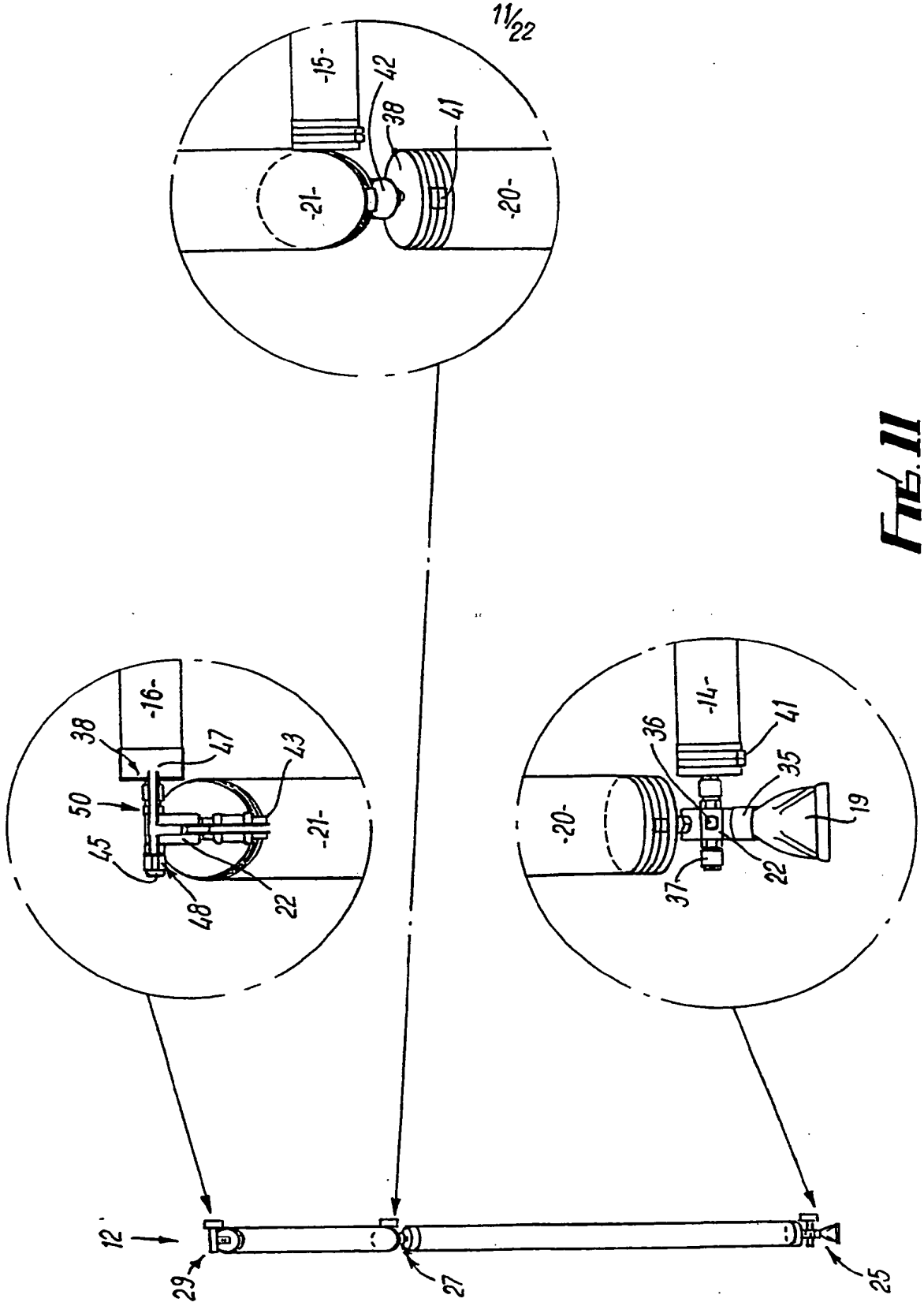
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FIG. II

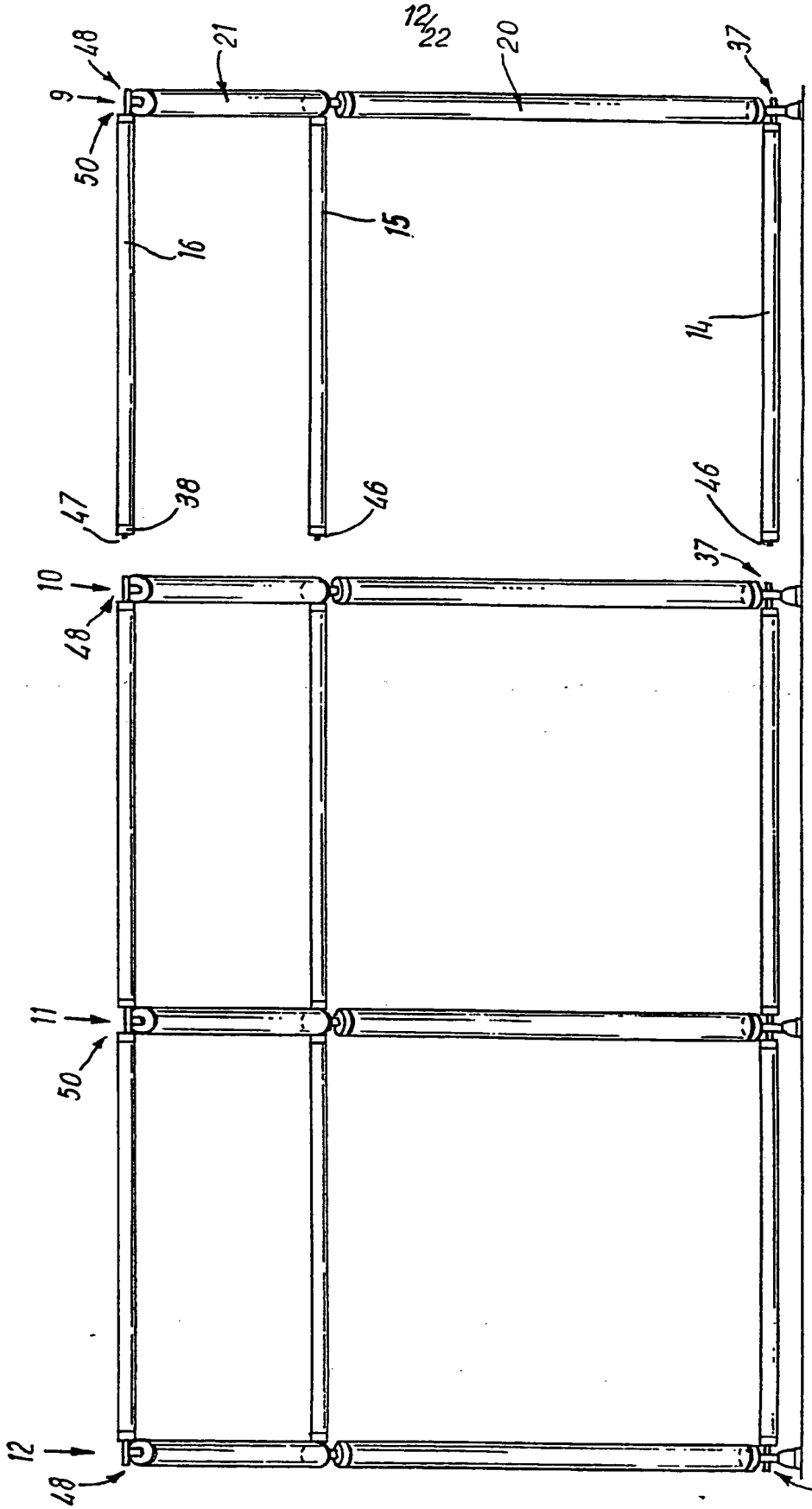

FIG 12

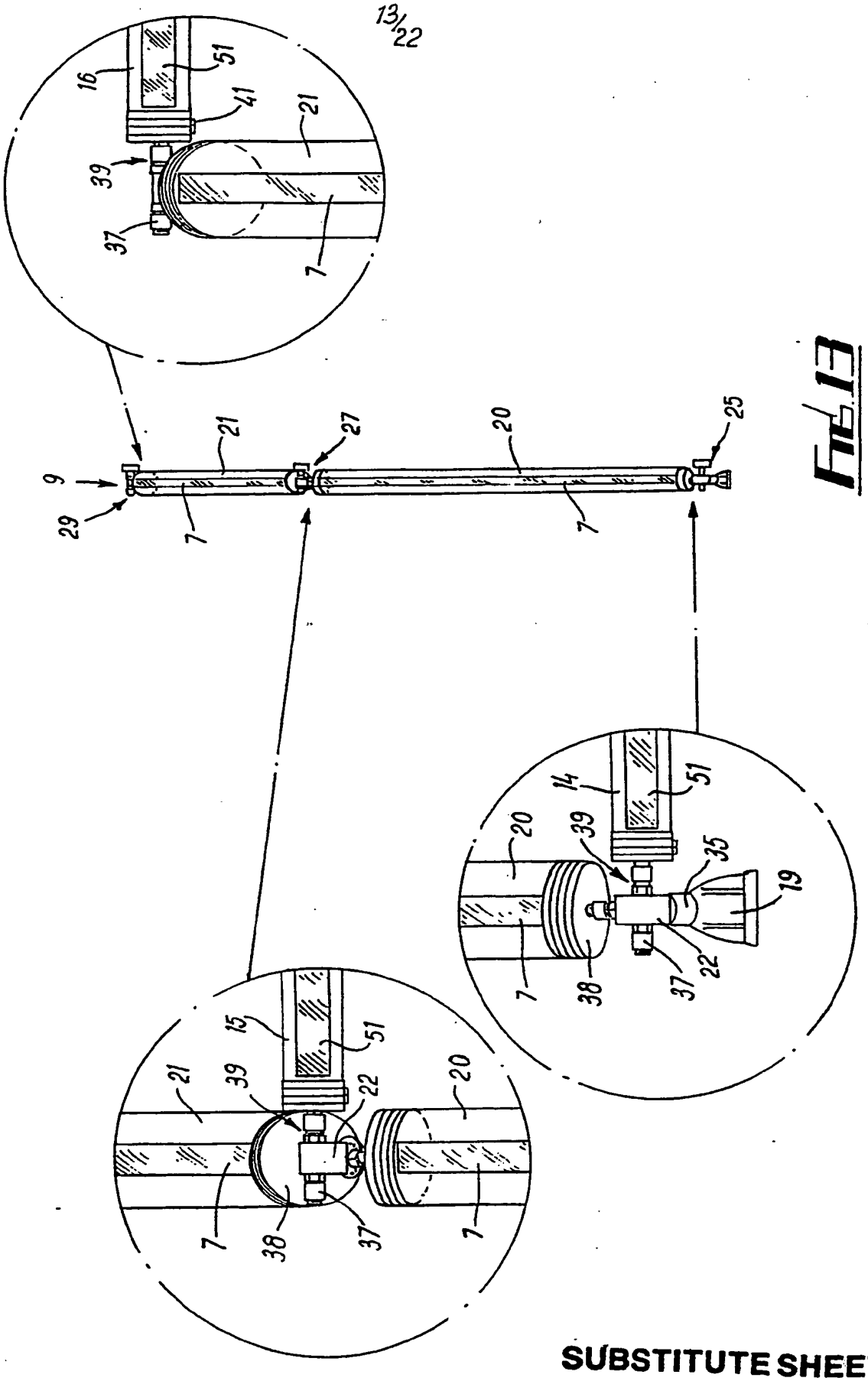
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FIG.13

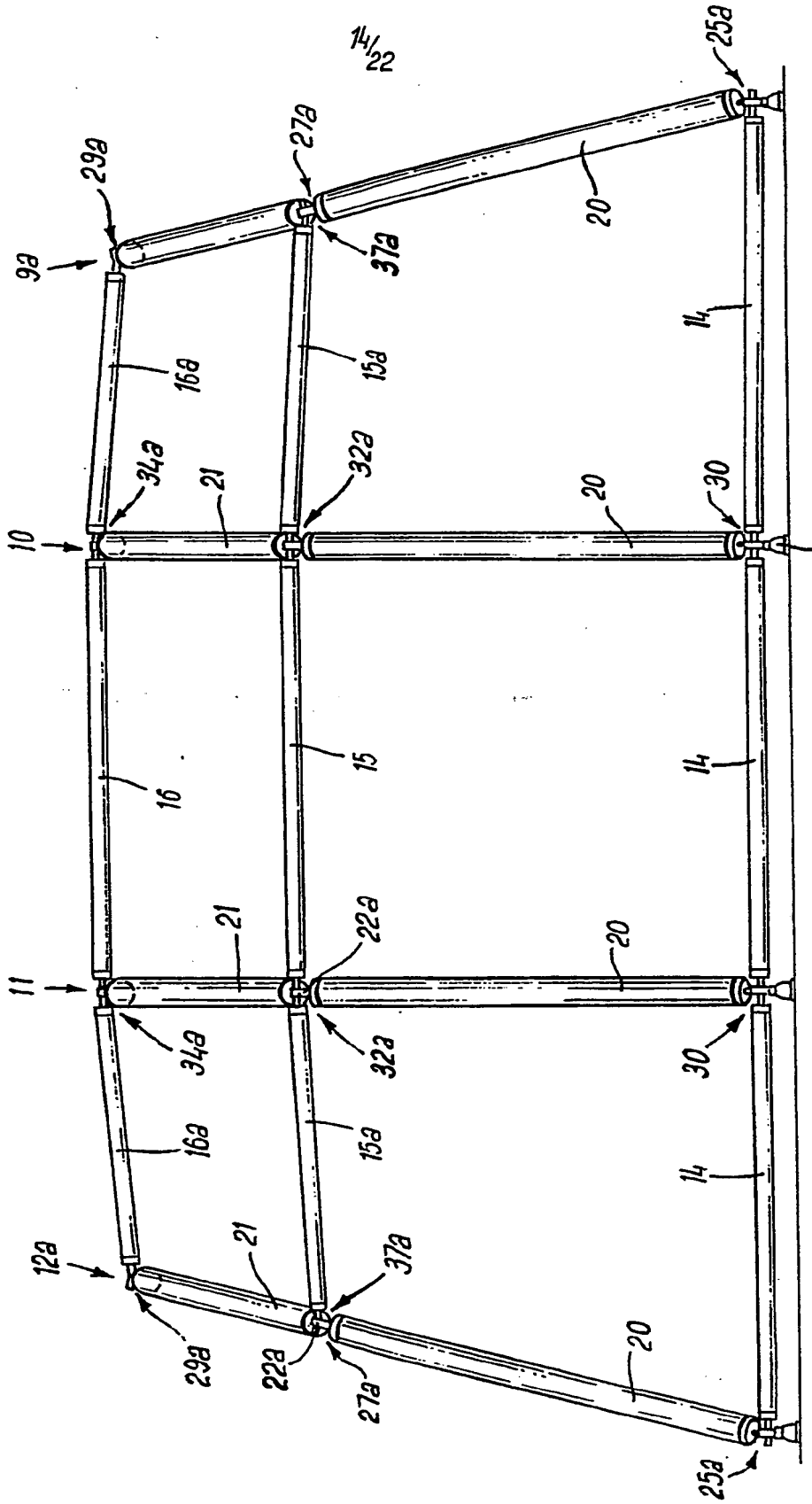
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FIG. 14

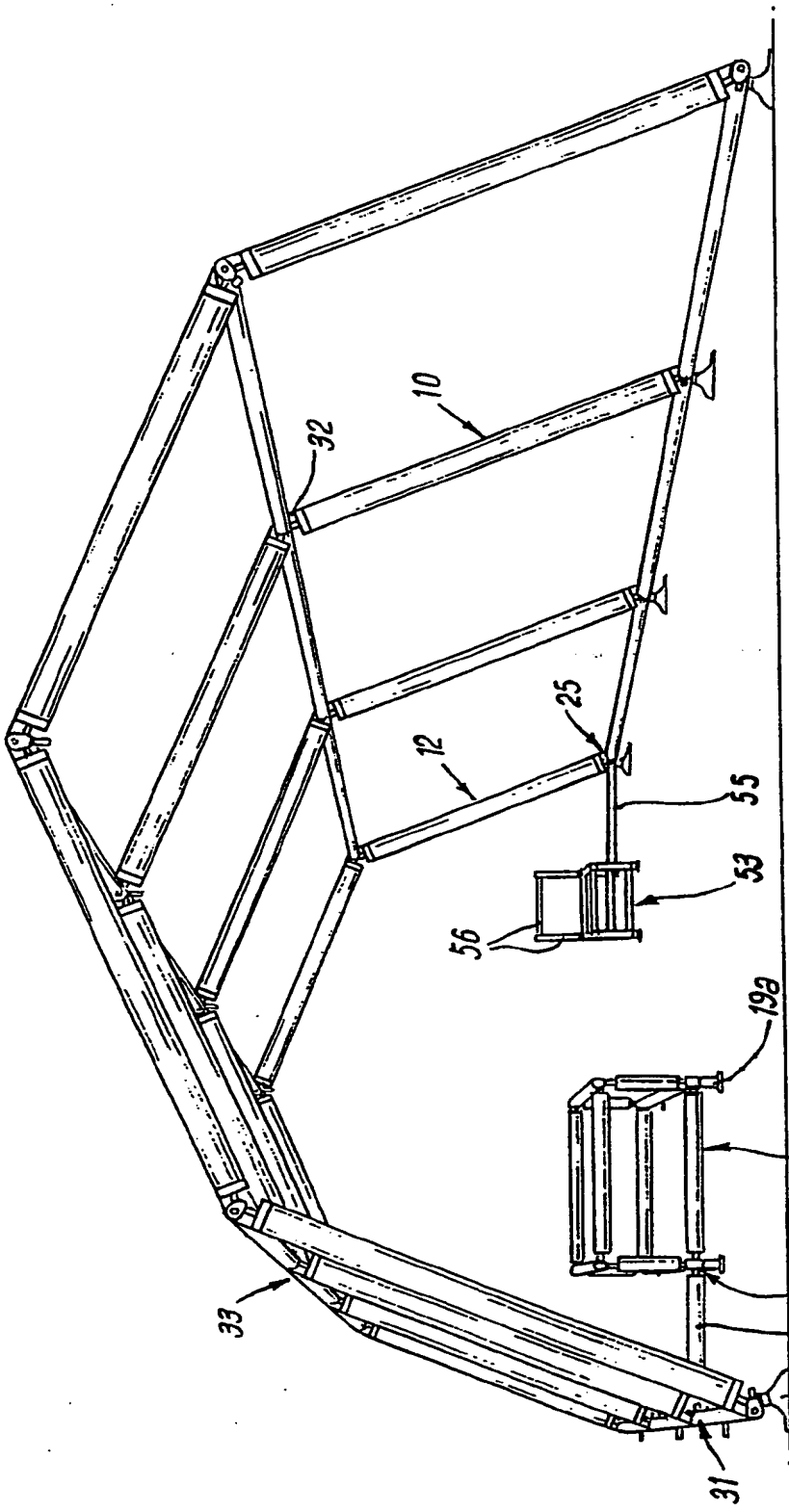

FIG. 15

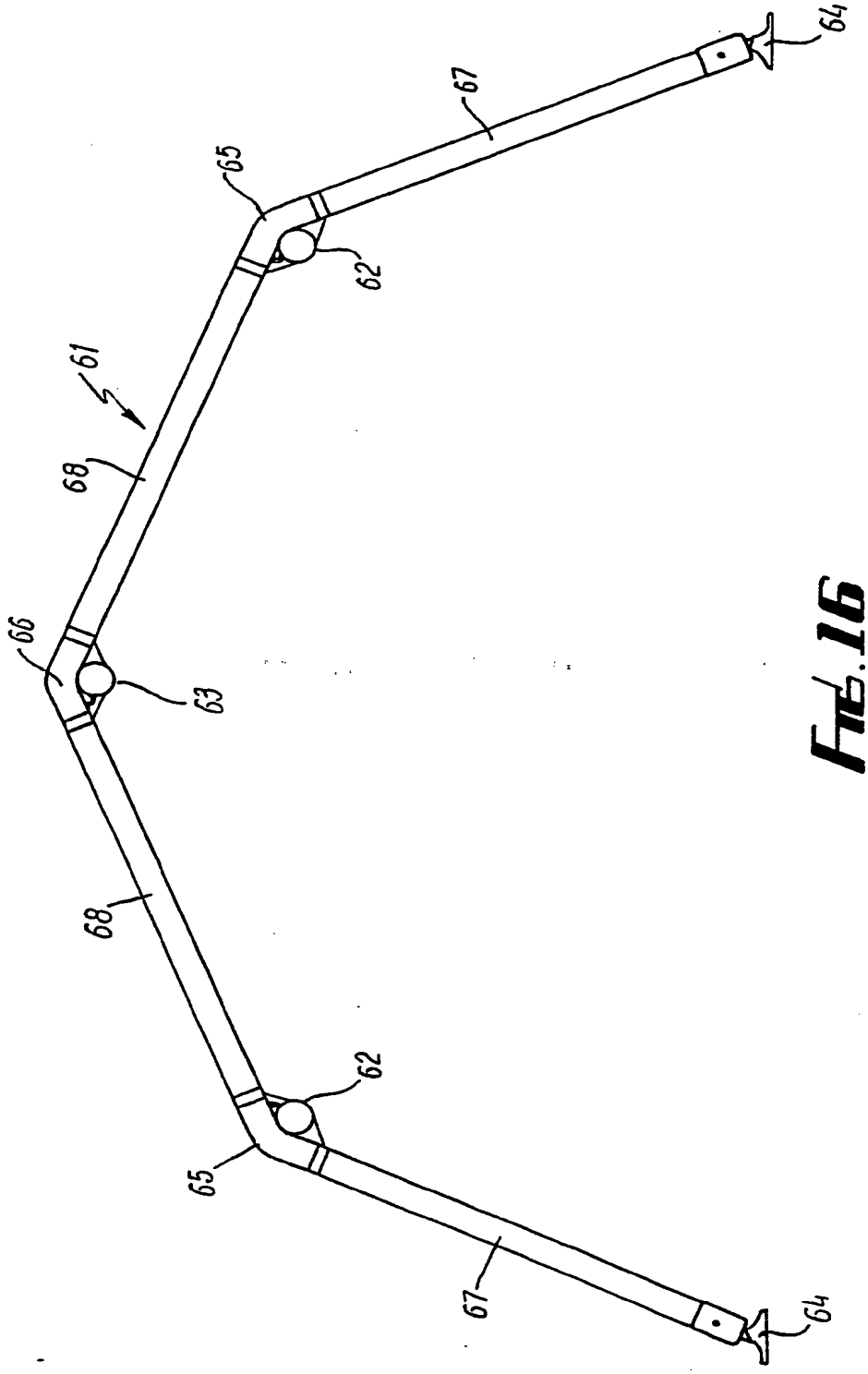

FIG. 16

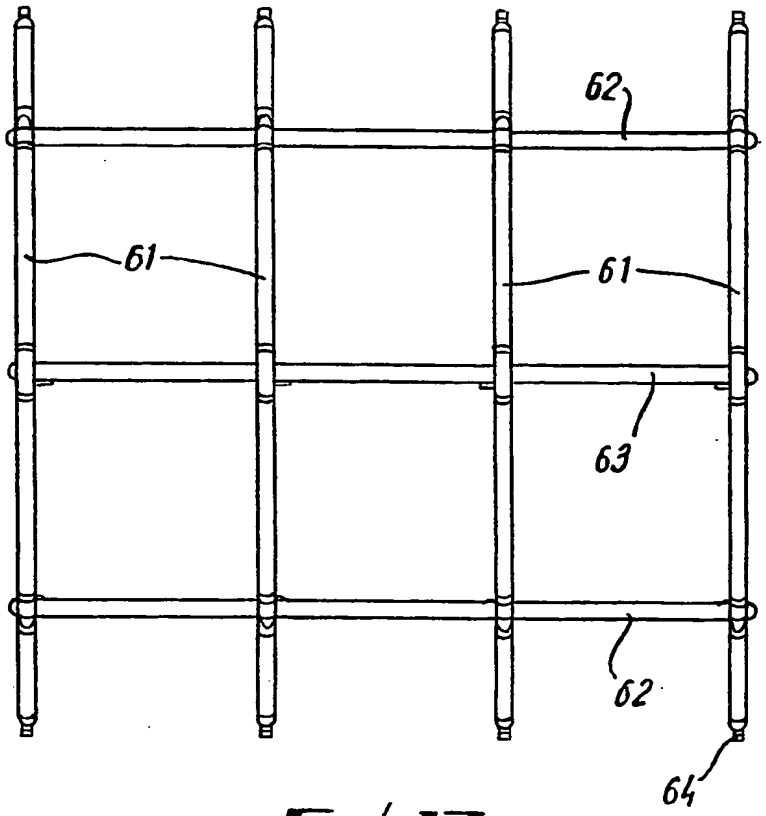

FIG. 17

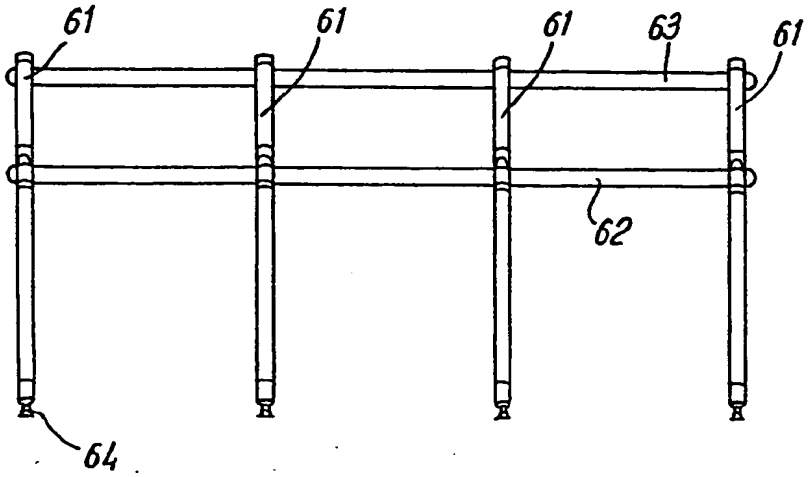

FIG. 18

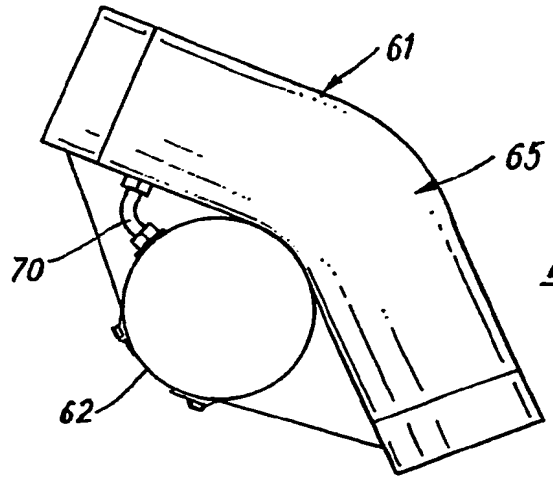

FIG. 19

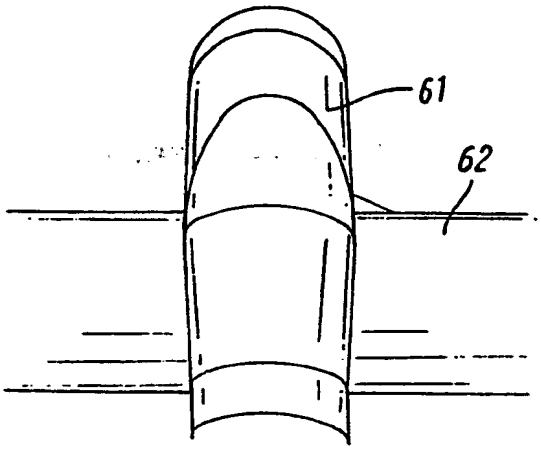

FIG. 20

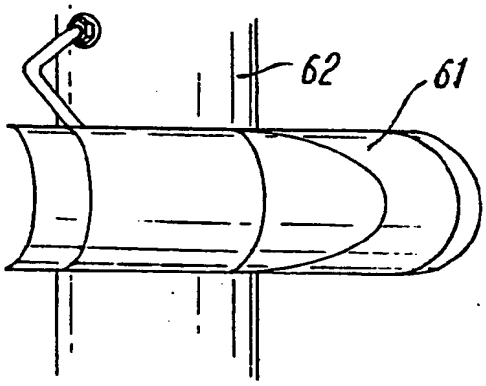

FIG. 21

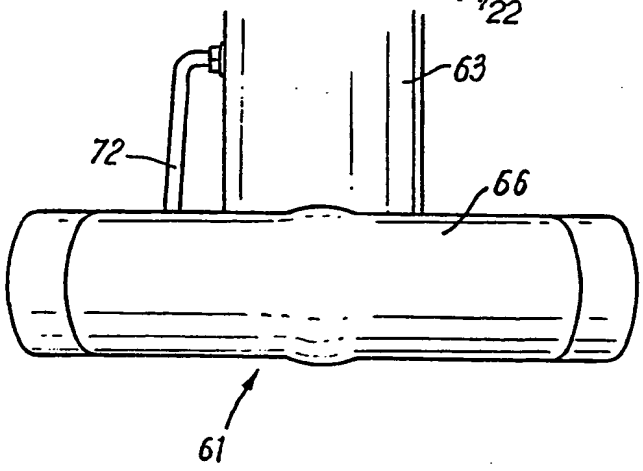

FIG.22

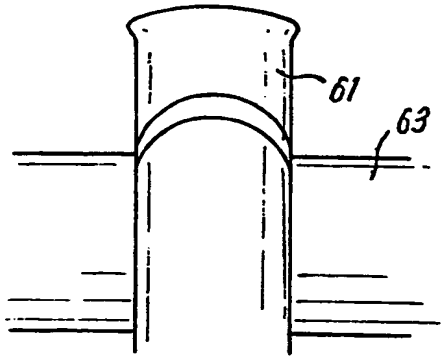

FIG.23

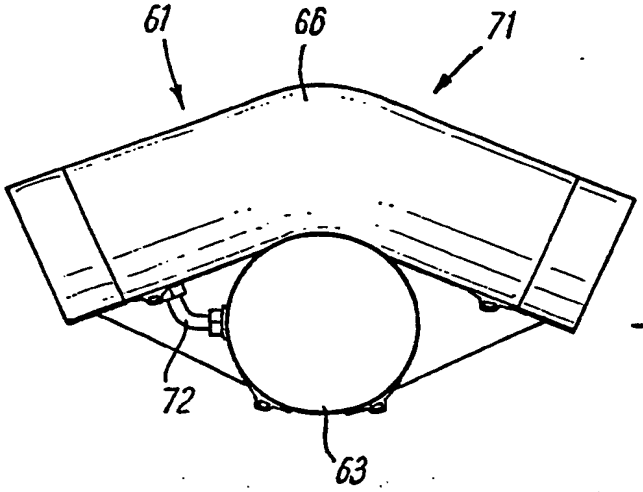

FIG.24

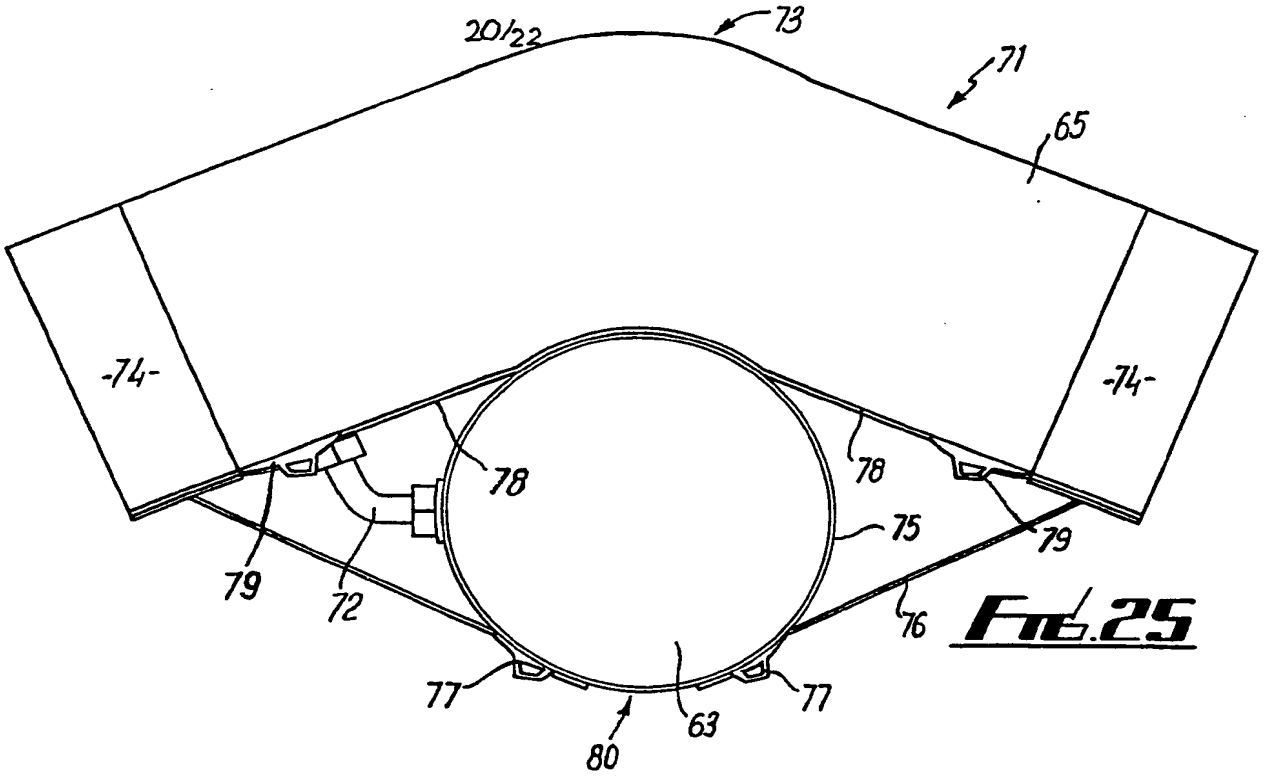

FIG. 25

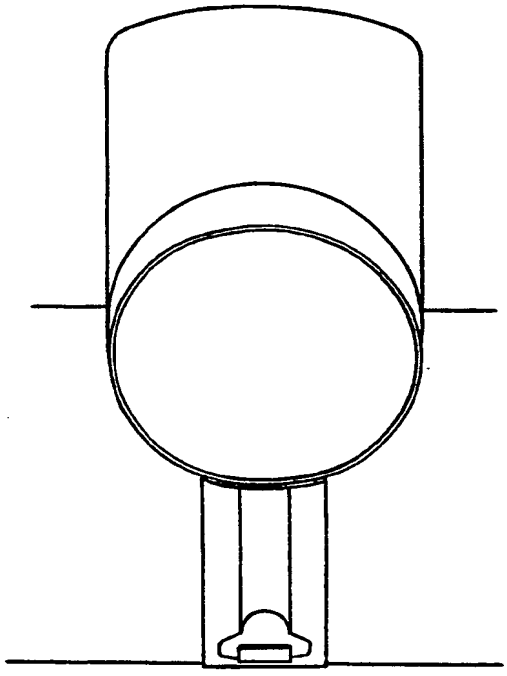

FIG. 26

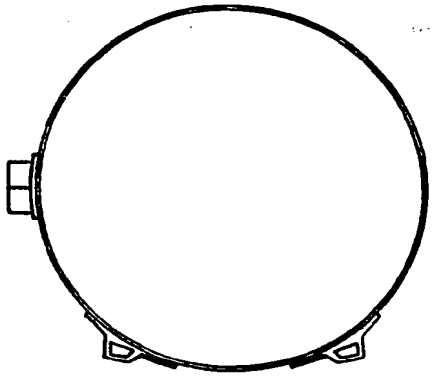

FIG. 27

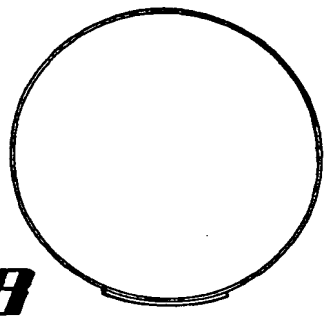

FIG. 28

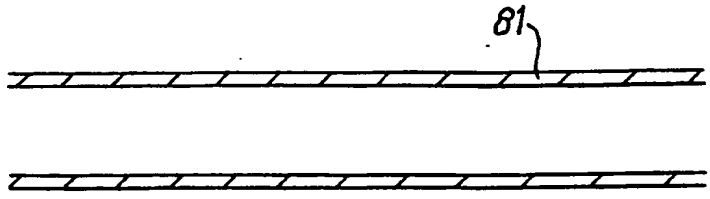

FIG. 29

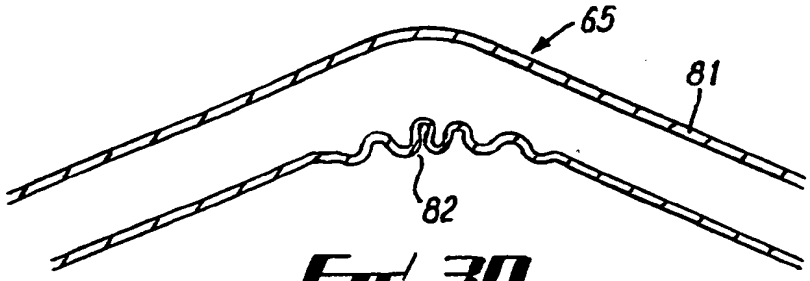

FIG. 30

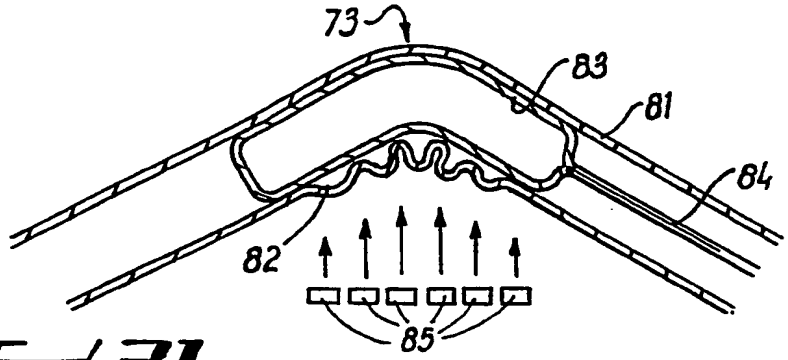

FIG. 31

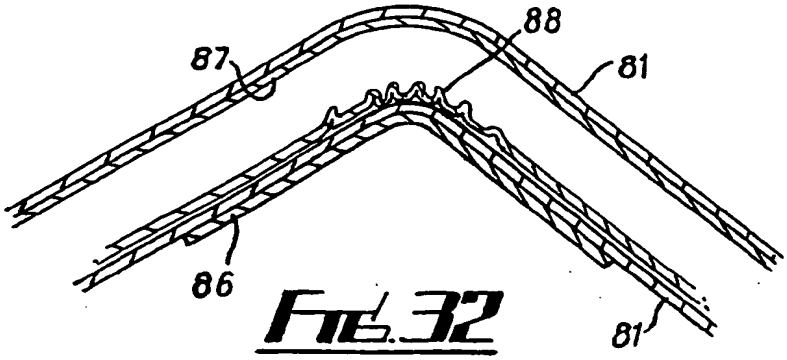

FIG. 32

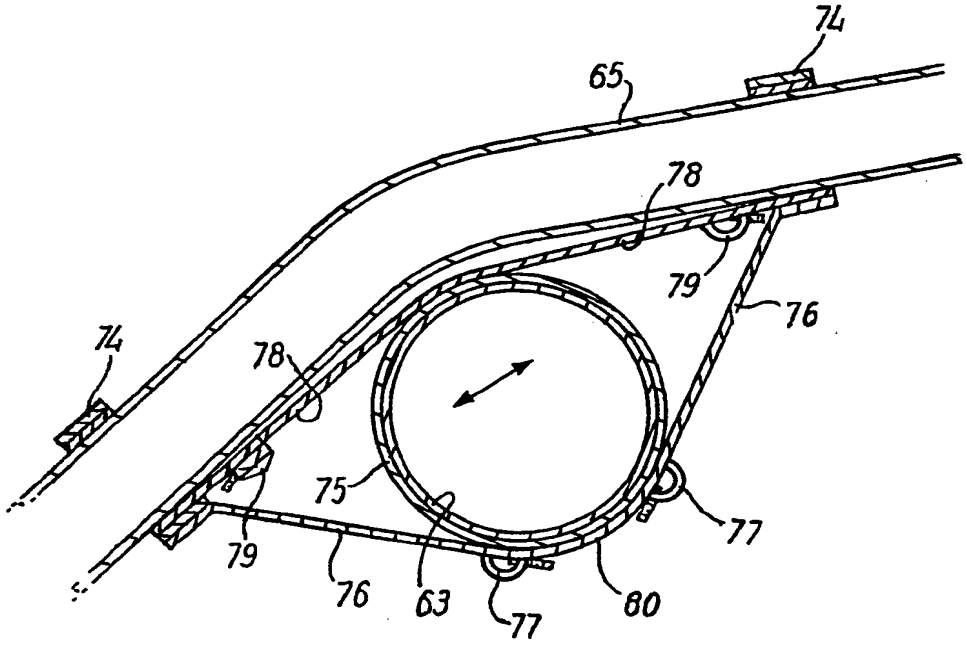

FIG. 33

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 90/00836

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: E 04 H 15/20

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	E 04 H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	FR, A, 2341017 (POTOCKI & ADER) 9 September 1977 see the whole document	1,2,25,37, 38
Y		3,4,13,18, 26,34,35
A		29
	--	
X	US, A, 3145719 (JOHNSON) 25 August 1964 see column 2, line 38 - column 3, line 12; figures 1,2	1,2,14,25, 37-39
	--	
Y	WO, A, 81/00125 (BROWN) 22 January 1981 see page 2, lines 1-13; page 4, line 5 - page 6, line 17; figures 7A-7D	3,13,18

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20th August 1990	26.09.90
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Mme N. KUIPER

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, ** with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A		19
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Y	BE, A, 661239 (DYNAMIT NOBEL AG) 16 July 1965 see page 1, line 1 - page 2, line 24	4
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Y	US, A, 4197681 (HOLCOMBE) 15 April 1980 see column 5, lines 7-40; figures 6,9	26
A		5,15
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Y	EP, A, 0036051 (HSU) 23 September 1981 see page 2, line 5 - page 3, line 6	34,35
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A	US, A, 2191374 (DIXON) 20 February 1940 see the whole document	4
A	US, A, 2591829 (KATZENMEYER) 8 April 1952 see column 6, lines 16-62; figures 1,4,10,11	15
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P,Y	WO, A, 89/04757 (STEWKIE SYSTEMS LTD) 1 June 1989 see page 9, line 24 - page 10, line 24; page 14, line 26 - page 15, line 8; figures 1,7-10 (cited in the application)	4
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A	WO, A, 87/03534 (STEWART) 18 June 1987 (cited in the application)	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9000836 SA 37299

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 18/09/90 The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2341017	09-09-77	None	
US-A- 3145719		None	
WO-A- 8100125	22-01-81	AU-A- 6055880	03-02-81
		GB-A- 2079343	20-01-82
BE-A- 661239	16-07-65	DE-B- 1266953	
		GB-A- 1100120	
		NL-A- 6502923	22-09-65
US-A- 4197681	15-04-80	None	
EP-A- 0036051	23-09-81	US-A- 4332112	01-06-82
US-A- 2191374		None	
US-A- 2591829		FR-A- 1048645	
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